September 3, 1956 50 Cents

AVIATION WEEK

A McGRAW-HILL PUBLICATION

Airlines Outline Helicopter Needs

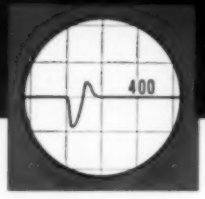
•

Fairchild Sees Big Potential for Jet

Thompson Trophy Winner

First in Constant Speed Drives...

SUNDSTRAND



New electrical concept in 707 makes use of Sundstrand Constant Speed Drives

Boeing engineers applied a new concept in electrical systems to the 707 for several sound reasons. Sundstrand Constant Speed Drives had proved themselves in military service. They made possible an automatic, paralleled, constant frequency a-c system supplying plenty of stable power, with heavy overload capacity under all flight conditions. The new system offered reliability, low-cost operation, plus necessary capacity with less weight and easier utilization. Performance of this new jet airliner proves how the new concept in electrical systems . . . using Sundstrand's Constant Speed Drive . . . meets the challenge of today's . . . and tomorrow's . . . fast, high-flying jets. Could we help on your problem?

New Electrical Horizons . . .

are opening to design engineers, through co-operation between engine and airframe manufacturers and Sundstrand. With this new concept in electrical systems, expect remarkable advances in operation and performance of tomorrow's aircraft.

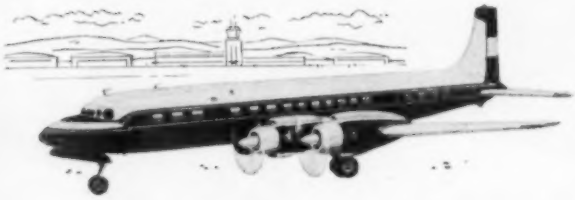
SUNDSTRAND AVIATION

Division of Sundstrand Machine Tool Company, ROCKFORD, ILLINOIS Western District Office: Hawthorne, California

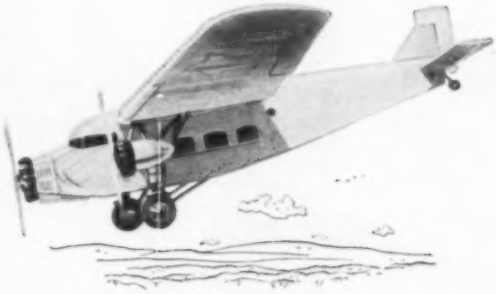
CONSTANT SPEED DRIVES • AIRCRAFT ACCESSORIES

1.

2.



3.



4.

Which airplane has the Disc-Type Brake?

Here they are: a jet, a helicopter, a huge modern transport and a famed early tri-motor. Which flies the disc-type brake, the famed braking principle developed by Goodyear for the aeronautics industry?

Ready with your answers? Here they are:

1. REPUBLIC F-84F—this famous jet is equipped with Goodyear Disc Brakes of the *Internal Type*, great brakes engineered for hot, high-speed landings.

2. SIKORSKY S-58—this helicopter uses Goodyear Brakes of the *Single Disc Type* in two applications: on the landing gear and on the rotor as well. You'll find Goodyear Disc Brakes on virtually every helicopter made today.

3. DOUGLAS DC-7C—this fast-flying airliner is a pioneer of something brand-new in super-efficient braking. Yes! They're Goodyear Disc Brakes of the new *Tri-Metallic Type*—engineered with the highest energy absorption capacity per pound of metal yet produced. Especially designed for high-capacity, weight-savings applications.

4. FORD TRI-MOTOR—this famous aircraft has a history of great service stretching back over three decades. Many were modified to utilize the Airwheel and a new braking principle developed by Goodyear at that time. The principle? *Multiple Disc Braking!*

In short, all of the aircraft shown here rely on Disc-Type Brakes built by Goodyear—as do a majority of the aircraft throughout the world.

The adaptability of the famed Goodyear principle, the almost limitless variations of the Disc Brake—and its complete dependability—have made it foremost in flying. It is convincing proof of the fact that Goodyear can engineer—for any aircraft—the most efficient brake with the desired characteristics and capacities.

Goodyear, Aviation Products Division,
Akron 16, Ohio, and Los Angeles 54, California

FACILITIES + ABILITIES
= EXTRA IN
PERFORMANCE

GOODYEAR
AVIATION
PRODUCTS

Airwheel—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

supersonic safety for America's airmen

WEBER EJECTION SEATS PROVIDE SPLIT-SECOND ESCAPE

Two seconds from decision . . . to parachute safety! That's all it takes a pilot of Convair's F-102A all weather, jet interceptor to abandon ship . . . if he gets into trouble . . . even at supersonic speeds. Ejection sequence starts when pilot raises hand grip to dump cabin pressure . . . unlock and jettison the canopy. Another 15° of movement of the hand grip raises forearm guards and locks shoulder harness inertia reel. Pressure on the trigger then *safely* ejects the pilot, and 2 seconds later his lap belt automatically opens freeing him from the seat. The ejection cycle is completed with only 30 lbs. of pressure on the hand grip, so pilot in positive G condition needs only to move his wrist to eject. Weber's design, development and production skills are daily being called upon to solve complex problems like this. Why not find out how a Weber engineering team can work for you?

MANUFACTURERS OF: ejection seats · pilot and crew seats · passenger seats / buffets · wash basins and other interior equipment / Aerostands · Aeroramps / subcontractors of major airframe components

WEBER AIRCRAFT CORPORATION

2820 Ontario Street, Burbank, California

AVIATION CALENDAR

Sept. 3-7—Canadian National Air Show, Toronto, Canada.

Sept. 3-9—Society of British Aircraft Constructors' 17th Annual Air Show, Royal Aircraft Establishment, Farnborough, Hampshire, England.

Sept. 5-7—Symposium on Atmospheric Optics, sponsored by Physical Research Labs., Boston Univ., Sargent Camp, Peterborough, N. H.

Sept. 6—Seventh annual Engine Operation & Maintenance Forum, sponsored by Airwork Corp., Pratt & Whitney Aircraft, at Airwork Corp. and Millville Airport, Millville, N. J.

Sept. 8—First annual National Convention of the OX-5 Club, Williamsport, Pa. Contact: Clifford Ball, Secy., OX-5 Club, 214 Plaza Bldg., Pittsburgh, Pa.

Sept. 9-11—International Northwest Aviation Council, 20th annual convention, Boise, Idaho.

Sept. 10—Pratt & Whitney, Southwest Airmotive Co., Engine Forum, Melrose Hotel, Dallas, Tex.

Sept. 10-14—American Society of Mechanical Engineers, Instrument & Regulators Div. Meeting, Detroit, Mich.

Sept. 14-15—Conference on Communications, Roosevelt Hotel, Cedar Rapids, Iowa.

Sept. 17-21—American Society for Testing Materials, Second Pacific National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif.

Sept. 17—International Air Transport Association, 12th annual general meeting, Edinburgh, Scotland.

Sept. 17-21—Eleventh Annual Instrument-Automation Conference & Exhibit, sponsored by the Instrument Society of America, Coliseum, New York, N. Y.

Sept. 17-22—International Congress of Astronautics, sponsored by the International Astronautic Federation, Rome, Italy.

Sept. 18-20—Twenty-fourth USAF-Aircraft Industry Flying Safety Conference, sponsored by USAF Flight Safety Research, Santa Barbara, Calif.

Sept. 24-26—American Rocket Society, fall meeting, Hotel Statler, Buffalo, N. Y.

Sept. 24-28—1956 Trade Fair of the Atomic Industry, Navy Pier, Chicago, Ill.

AVIATION WEEK • SEPTEMBER 3, 1956
Vol. 65, No. 10

Published weekly with an additional issue in December by the McGraw-Hill Publishing Company, James H. McGraw (1860-1948), Founder. Executive, Editorial, Advertising and Subscription offices: **McGraw-Hill Building, 330 West 42nd Street, New York 36, N. Y.** Publication Offices: 99-129 North Broadway, Albany 1, N. Y. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice President, Publications Division; Ralph B. Smith, Vice President and Editorial Director; Joseph T. Allen, Vice President and Director of Advertising Sales; J. E. Blackburn, Jr., Vice President and Circulation Director.

Subscription: Address correspondence to AVIATION WEEK—Subscription Service, 99-129 North Broadway, Albany 1, N. Y. or 330 West 42nd St., New York 36, N. Y. Allow 10 days for change of address.

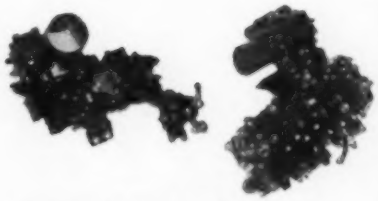
Subscriptions are solicited only from persons who have a commercial or professional interest in aviation. Position and company connection must be indicated on subscription orders.

Single Copies 50c. Subscription rates—United States and possessions, $6 a year; $9 for two years; $12 for three years. Canada $8 a year; $12 for two years; $16 for three years, payable in Canadian currency at par. Other Western Hemisphere and the Philippines $10 a year; $16 for two years; $20 for three years. All other countries $20 a year; $30 for two years; $40 for three years. Second class mail privileges authorized at Albany 1, N. Y. Printed in U. S. A.

Copyright 1956 by McGraw-Hill Publishing Co. Inc. All Rights Reserved. Cable Address: "McGraw-Hill New York." Publications combined with AVIATION WEEK are AVIATION, AVIATION NEWS, AIR TRANSPORT, AERONAUTICAL ENGINEERING and AIRCRAFT JOURNAL. All rights to these names are reserved by McGraw-Hill Publishing Co.

XLO

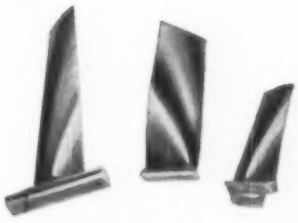
Ex-Cell-O Precision at Production Prices



FUEL CONTROL AND METERING ASSEMBLIES

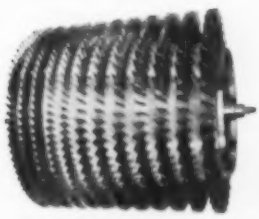
HYDRAULIC & PNEUMATIC ACTUATOR ASSEMBLIES

FUEL NOZZLES FOR JET ENGINES



JET ENGINE BLADES

MISCELLANEOUS AIRCRAFT AND COMMERCIAL PRECISION PARTS



JET COMPRESSOR ROTORS

Ex-Cell-O's facilities include laboratory control of materials, design and process engineering, machining of all materials, complete quality control to meet the most rigid specifications, and delivery to meet customers' requirements.

For information or a quotation, write or phone the Precision Products Division of Ex-Cell-O.

54-2

EX-CELL-O CORPORATION • DETROIT 32, MICHIGAN

MANUFACTURERS OF PRECISION MACHINE TOOLS • GRINDING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • DAIRY EQUIPMENT

INTRODUCING...

the first combined

GPC AND DDA

GENERAL PURPOSE DIGITAL COMPUTER AND DIGITAL DIFFERENTIAL ANALYZER

ultimate versatility in solving complex technical problems...

The general purpose digital computer solves most scientific and engineering problems with speed and accuracy... yet easier programming makes the digital differential analyzer a superior choice for solving differential equations. Bendix now combines the advantages of both in the *new* G-15D Computer and its optional DDA accessory. Working together, and supported by a full complement of input-output equipment, these units provide the *best* means of solution. And the rental or purchase cost is far below that of most general purpose computers alone.

A new brochure tells the details of the G-15D's talent for conserving your scarce engineering manhours. Let us send you a copy.

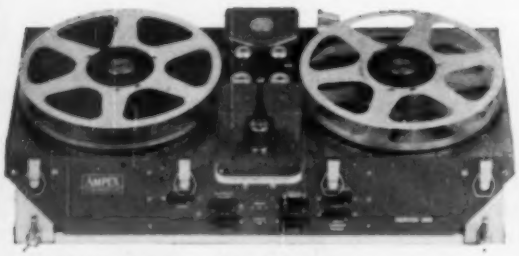
Bendix Computer

DIVISION OF BENDIX AVIATION CORPORATION

5630 ARBOR VITAE STREET, LOS ANGELES 45, CALIFORNIA

AMPEX 800

THE MAGNETIC RECORDER YOU CAN SPECIFY WITH CONFIDENCE



A PARTIAL LIST OF AMPEX 800 USERS

Aircraft Companies:
Boeing, Seattle
Boeing, Wichita
Glenn L. Martin
Lockheed
North American
Douglas

Air Force Bases:
Patrick
Edwards
Eglin
Wright-Patterson

Navy Installations:
Navy Radiological Defense Lab
Naval Air Development Center, Johnsville
Naval Ordnance Lab

Other:
Sandia Corporation
R C A
Cambridge Research Center
Radioplane
Texas University
Bell Telephone Labs
Federal Telecommunications Labs
General Electric Co.
Airborne Instruments

This installation of an Ampex 800 Airborne Magnetic Recorder in an F-80 at Edwards Airforce Base is at the heart of a major project for developing faster data recording and reduction techniques. Over twenty aircraft companies, government test facilities and others have also purchased Ampex 800s and received delivery in quantity during its first year of production.

The Ampex 800 has had quick acceptance because it has lived up to promise. When the model was publicly announced, it was already a completed and tested design. The Ampex 800 was backed by more experience in magnetic tape instrumentation than exists anywhere else in the world. It was ready to perform with utmost reliability. It was capable of recording the entire flight test data on a single tape. And on a production basis it met specifications in all details.

For full information and specifications, write Dept. UU-2757

District Offices: *New York; Chicago; Atlanta; Redwood City; Dayton; Silver Springs, Maryland (Washington D.C. Area)*
Distributors: *Technical Apparatus Co., Boston; Bing Crosby Enterprises, Los Angeles; Southwestern Engineering & Equipment, Dallas and Houston; Ampex-American in Canada*

INSTRUMENTATION DIVISION
AMPEX CORPORATION

FIRST IN MAGNETIC TAPE INSTRUMENTATION

934 Charter Street • Redwood City, California

Defending Today's USAF Bombers . . . .

16 YEARS' SYSTEMS ENGINEERING EXPERIENCE BACKS B-47 AND B-52 ARMAMENT PRODUCED BY GENERAL ELECTRIC'S AIRCRAFT PRODUCTS DEPARTMENT

TODAY all Boeing B-47 and most operational B-52 Air Force Bombers are equipped with electronic defense systems designed and developed by General Electric. The evolution of systems engineered bomber defense since 1940 has brought about today's completely integrated armament equipment, remotely operated by a single Air Force gunner.

Electronic Armament From General Electric

1940 General Electric entered the bomber armament field with amplidyne turret drives for the Consolidated Aircraft B-24 Liberator.

1942 Boeing B-29 Superfortress was defended by the first remote-control armament system including General Electric controls and turrets.

1944 G-E control and turrets linked with a periscopic sight allowed Douglas B-26 gunner to aim and fire both upper and lower turrets by remote control.

1945 Standard equipment on the Boeing B-50 included an advanced General Electric, remote-controlled armament sighting system.

1949 Convair B-36 is armed with a complete G-E defense system including turrets, sighting stations, radar control and a G-E electronic computer.

1956 The Douglas B-66 was the first tactical bomber to be equipped with radar-directed, automatic tail armament system.

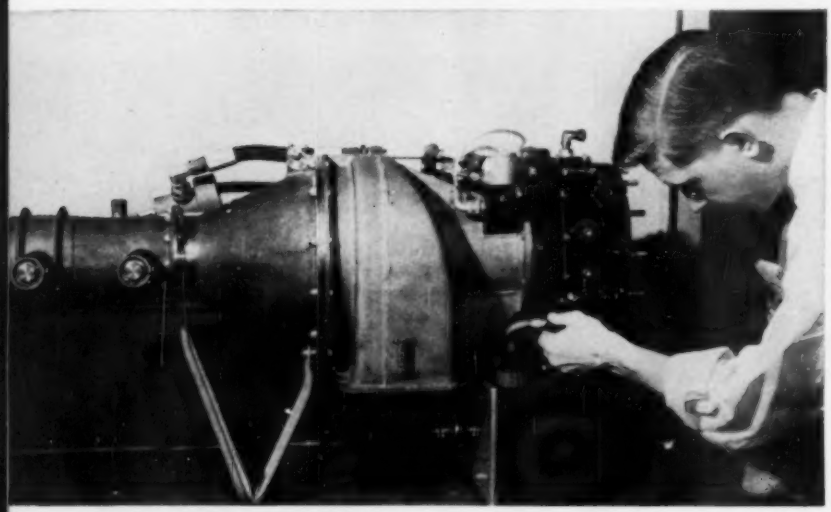
222-4

ENGINEERS: *Expanding electronic bomber defense projects at G.E. are creating opportunities for you. Contact C. E. Irwin, Aircraft Products Department, Johnson City, N. Y.*

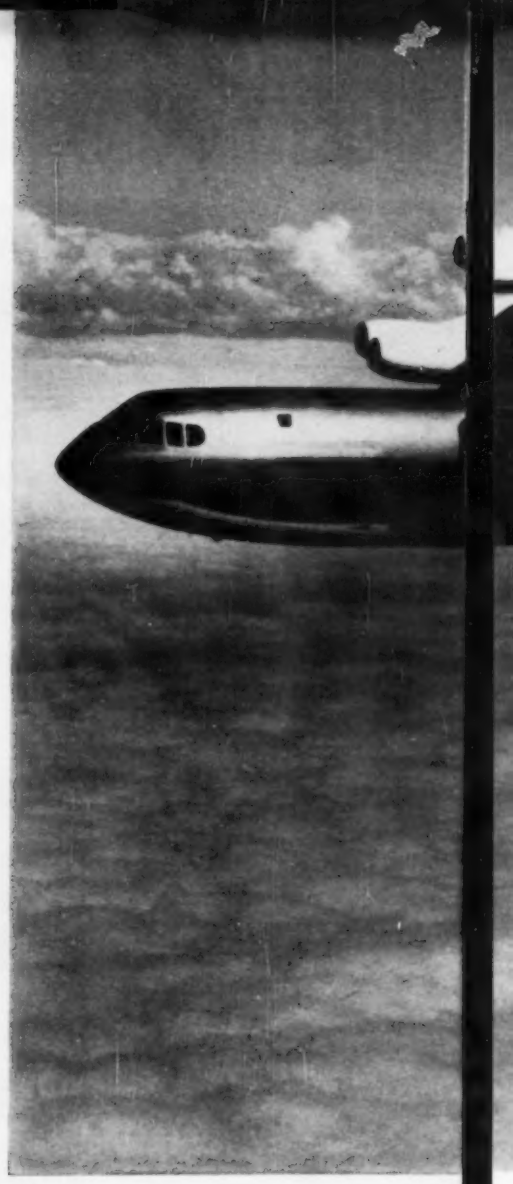
Progress Is Our Most Important Product

GENERAL ELECTRIC

G-E TURBOPUMPS ON THE B-52 are driven by air ducted from the jet engines. These units supply the hydraulic power necessary to operate the bomber's steering, empennage surfaces, landing gear, bomb-bay doors, and wing spoilers.



G-E TURBODRIVES ON THE B-52 also operate on air ducted from the engines. These constant-speed drives each turn a 60-kva, 400-cps alternator which produces electricity for the B-52's radar, lighting, armament, and control panels.



New General Electric Air-turbine Drives Save

The Boeing B-52 Stratofortress, newest Air Force jet bomber, uses General Electric turbopumps and turbodrives to help supply its hydraulic and electric power. Chalking up more than 100,000 hours operating time, these weight-saving power packs have helped to make the giant bomber one of the most advanced aircraft in the world today.

OPERATING ON THE SIMPLEST OF PRINCIPLES, G-E turbopumps and alternator drives consist only of a turbine, gearing, and integral lubrication and control systems. Because their basic design requires very few moving parts, G-E turbopumps and drives are engineered to give long, dependable service under the most stringent operating conditions.

COMPACT AND SELF-CONTAINED, these units are located near the point where power is needed. Such versatile, remote location reduces "drag" by cutting engine nacelle size, and eliminates the weight of long

Progress Is Our Most Important Product

GENERAL ELECTRIC

THE B-52—first aircraft in history to use pneumatic-driven power equipment for operating its entire accessory system.

Weight, Permit Increased B-52 Performance

transmission lines. The lighter system weight obtained with G-E turbopumps and drives permits increased aircraft range, speed, or payload.

TOP RELIABILITY OF AIR-TURBINE DRIVES is achieved by cross-manifolding the plane's air supply ducts. Through this method, all drives aboard the aircraft can be operated on air from one or any combination of engines.

FOR DETAILED INFORMATION on how G-E turbopumps and turbodrives, manufactured by General Electric's Aircraft Accessory Turbine Department in Lynn, Mass., can answer the accessory power needs of your aircraft, contact your General Electric Aviation and Defense Industries Sales Office, or clip coupon for free descriptive bulletins. 231-7

General Electric Co., Section 231-7

Schenectady 5, N. Y.

Please send me bulletins GEA-5870A, GEA-6333 and GER-973 on turbopumps and drives.

I am requesting this information

☐ for immediate project

☐ for Reference only

Name .....

Position .....

Company .....

City ..... Zone .... State .....

Today's challenging requirements for supersonic rocket power sources capable of superior performance depend heavily for their fulfillment upon continuous research in previously unexplored chemical fields.

In RMI's new, completely equipped chemistry laboratories, important research projects are continuously contributing to the advancement of rocket technology through the development of new high-energy liquid and solid propellants and through the investigation of other areas of rocket technology dependent upon chemistry for their improvement. Thus, in designing and producing new rocket engines for many important applications, RMI is providing vital assistance to its own engineers and the rocket industry through chemical research.

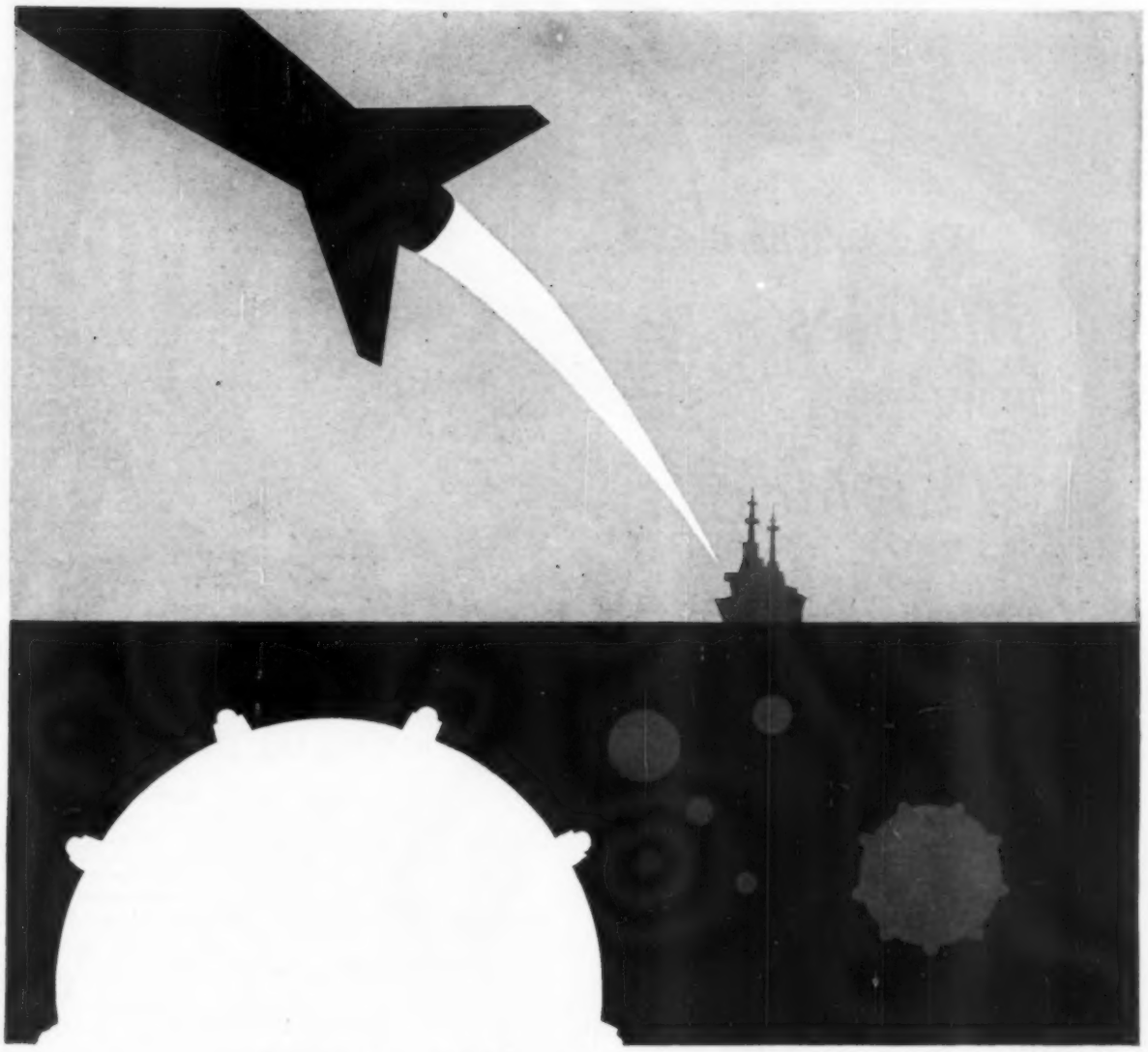
Spearheading Progress through Research

RMI

REACTION MOTORS, INC.

Denville, New Jersey

A MEMBER OF THE TEAM



From deadly sea "bird" to underwater "nest"

AMF has experience you can use

● Designing and producing ultra-modern ship-borne weapons, or building less spectacular but highly important underwater mines, AMF is engaged in hundreds of such complex tasks every day ● The highly specialized yet widely diversified activities of some 35 engineering and production facilities provide AMF with a wealth of experience that covers nearly every field of industry. And it is immediately available to you ● Call upon AMF with your problem. See for yourself why this all-around experience in answering the needs of government and industry alike has made AMF the "can do" company.

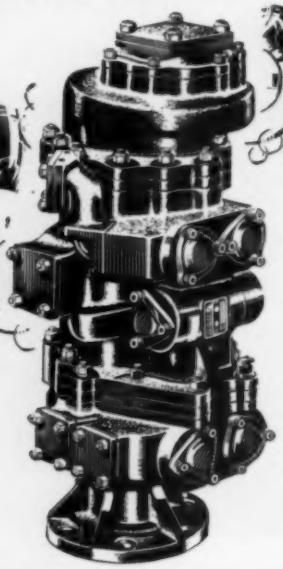
Research, Development, Production in these fields:
- *Armament*
- *Ballistics*
- *Radar Antennae*
- *Guided Missile Support Equipment*
- *Auxiliary Power Supplies*
- *Control Systems*

Another AMF Product
DEFENSE PRODUCTS

Defense Products Group
AMERICAN MACHINE & FOUNDRY COMPANY
1101 North Royal Street, Alexandria, Va.

Way up where

Bubbles mean Troubles...



Chandler-Evans FUEL PUMPS Eliminate the problem

Flying at high altitudes causes bubbles in fuel lines. If tank-mounted booster pumps fail, high capacity fuel pumps of conventional design "commit suicide" in minutes, pumping bubbles instead of solid fuel. Providing an extra margin of safety to protect plane and pilot, CECO Fuel Pumps incorporate a high capacity booster as an integral part of the unit. This pump "squeezes" the bubbles out of the fuel and insures continued dependable functioning even though tank-mounted boosters should fail to operate.

If your projects demand something extra in performance and reliability, CECO has the advanced design Pumps and other Fuel Controls you need.

CECO OFFERS CAREER OPPORTUNITIES FOR YOUNG ENGINEERS

... who want to play an important position on a developmental team ... who want the responsibility of originating and carrying through their own ideas on vital research projects. Write direct to our Chief Engineer, Mr. A. M. Wright.

CECO *Chandler-Evans*

CHARTER OAK BOULEVARD, WEST HARTFORD 1, CONN.

Makers of Jet Aircraft Accessories Produced TODAY to meet TOMORROW'S Progress

VICKERS

AIRBORNE HYDRAULIC IN-LINE RELIEF VALVES

setting a new standard of airborne relief valve performance

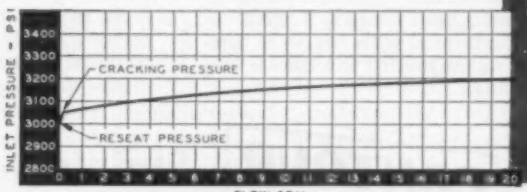
3000 psi series. Available in ¼", ⅜", ½" and ¾" tube size (¾" not shown)

Exceptionally "flat" performance, negligible hysteresis, minimum pressure sag at high temperature, outstanding accuracy and durability . . . these are the important characteristics of Vickers Airborne In-Line Relief Valves. • They have a direct-operated poppet with a high spring force (at low spring stress) available for reseating. Sliding parts are hardened steel and there are **no sliding o-rings.** A flow-compensating device permits very low differential between full flow pressure and reseat pressure . . . less than 300 psi for 150% rated flow on all sizes! • Conform in envelope to MS-28887 and internal parts have been developed to qualify in accordance with MIL-V-5523B Type II Specifications (reverse flow excepted). Adjustable to deliver rated flow over the range of 2300 to 3850 psi. • Tests at 550°F and severe vibration (25G's up to 2000 cps) indicate excellent performance under these conditions.

Write for Bulletin A 5212.

note low pressure change between full flow and reseat

TYPICAL IN-LINE RELIEF VALVE TEST PERFORMANCE



VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
ADMINISTRATIVE and ENGINEERING CENTER
Department 1462 • Detroit 32, Michigan

7493

Application Engineering and Service Offices: El Segundo, California, 2160 E. Imperial Highway • Detroit 32, Michigan, 1400 Oakman Blvd. (Service Only) Arlington, Texas, P. O. Box 213 • Washington 5, D.C., 624-7 Wyatt Bldg. • *Additional Service facilities at:* Miami Springs, Florida, 641 De Soto Drive
TELEGRAMS: Vickers WUX Detroit • TELETYPE "ROY" 1149 • CABLE: Videt
OVERSEAS REPRESENTATIVE: The Sperry Gyroscope Co., Ltd.—Great West Road, Brentford, Middx., England

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

now available from Trent–

Titanium Tubing

For processing lines carrying fluids of an extremely corrosive nature — look to *Contour Trentweld* titanium tubing for reliable service.

This titanium tubing is completely uniform throughout any cross-section. The weld zone is free from bulging weld bead because Trent's exclusive process — performed with the weld area at the bottom — forms the molten weld metal into the shape of the tubing.

And, with titanium, you get the unique advantages of a tubing that's strong as steel but 44% lighter . . . virtually immune to a broad spectrum of corrosive materials . . . entirely free from stress-corrosion cracking.

So, next time you need a strong, light, extremely corrosion-resisting tubing—try *Contour Trentweld* titanium tubing. And remember, it's made by Trent — tube mill specialists.

CONTOUR TRENTWELD

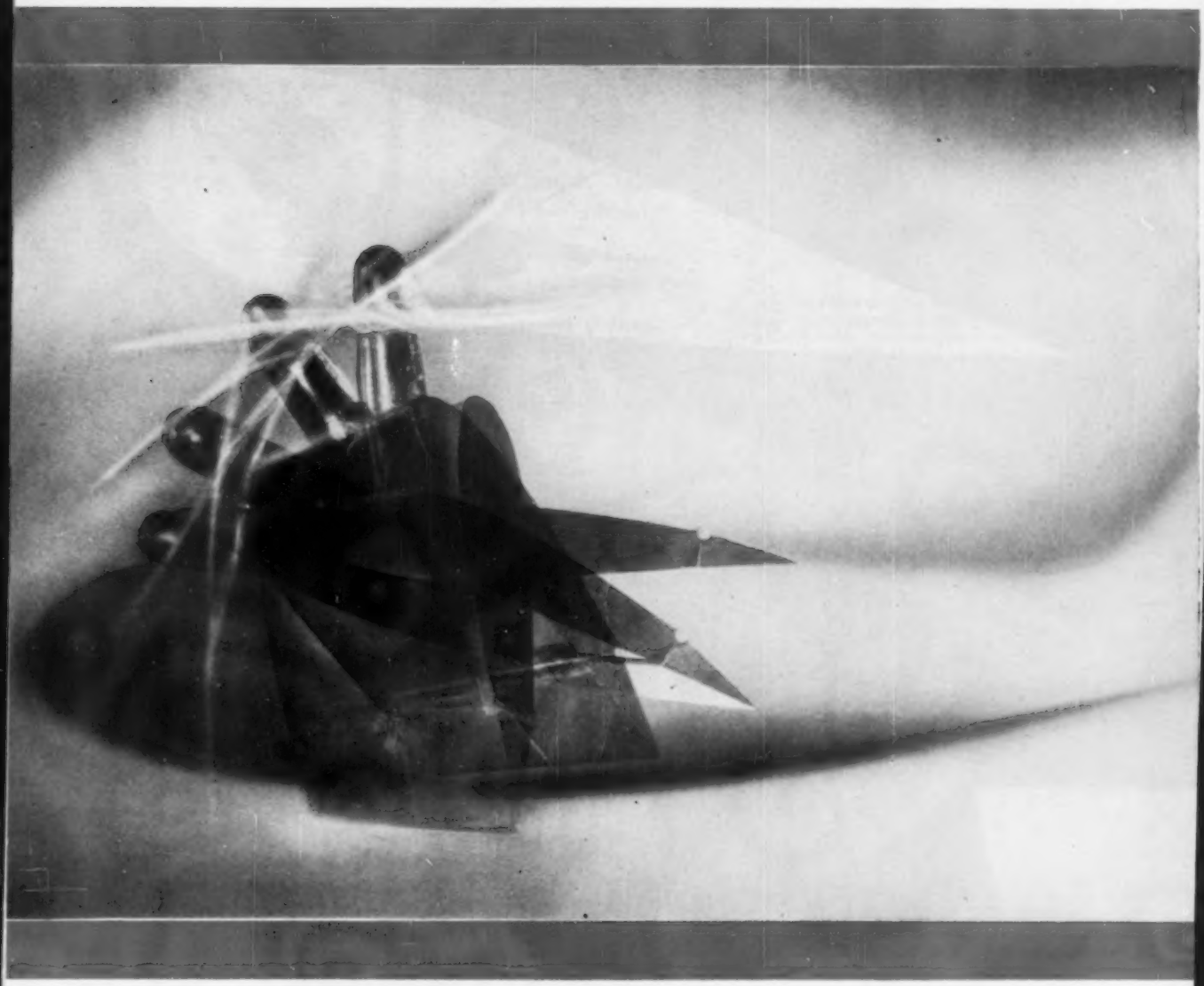
Stainless and High Alloy Welded Tubing

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN (Subsidiary of Crucible Steel Company of America)

Wings of old take on a new turn to bring true VTOL flight closer. Vertol research now takes on one of the most advanced assignments of the decade—high speed aircraft with vertical takeoff and landing capability.

Project: Vertol is now developing aircraft types which will fly as fast, as high, as far, as today's transports yet are able to take off and land at 0 mph forward speed.

Qualifications: Vertol's long-established leadership in the helicopter industry, Vertol's impressive research and development record in all aspects of vertical flight.



Progress: Vertol is currently developing a flying test bed for the Army under contract with the Office of Naval Research. In this aircraft—a small-scale variant of the larger, more powerful production types to come—a gas turbine drives rotor propellers housed in the wings of the aircraft. To takeoff and land vertically, both wings and rotor propellers pivot straight up; the rotor propellers furnish the necessary lift. At altitude, the wings tilt over into "normal" horizontal position, as the aircraft gathers flying speed; cruise is conventional and fast.

To give tomorrow's planes the universal landing and takeoff characteristics of today's helicopters is the essence of the Vertol "Skyways without Runways" concept.

VERTOL Aircraft Corporation

MORTON, PENNSYLVANIA

Engineers, join Vertol's advanced engineering team!

The sighting panels of the TF-102A, the combat proficiency trainer version of Convair's F-102A interceptor, are now being produced in Swedlow's recently developed stretched acrylics.

The culmination of a Swedlow-sponsored development program extending over several years, this process involves the molecular rearrangement of acrylic sheeting by mechanical stretching, improving toughness, resistance to solvent and stress crazing, reducing notch sensitivity and resulting in a substantial saving in weight.

For information on "Stretched Acrylics" and other plastic glazing materials, contact the Swedlow plant nearest you.

Swedlow
PLASTICS CO.

Los Angeles, California • Youngstown, Ohio

SEPTEMBER 3, 1956

AVIATION WEEK

VOL. 65 NO. 10

Editorial Offices

New York 36—330 W. 42nd St., Phone: LOngacre 4-3000 (Night LO 4-3035)
Washington 4, D. C.—National Press Bldg., Phones: NAtional 8-3414, REpublic 7-6630
Los Angeles 17—1125 West Sixth St., Phone: MAdison 6-9351

PUBLISHER.....Robert W. Martin, Jr.
EDITOR.....Robert B. Hotz

MANAGING EDITOR.....Alpheus W. Jessup
ASST. MANAGING EDITOR (TECHNICAL)
David A. Anderton
WASHINGTON.....Cecil Brownlow
NEW YORK.William Gregory, James J. Dailey
LOS ANGELES.Irving Stone, Richard Sweeney
ENGINEERING.....Robert H. Cushman,
Russell Hawkes
AVIONICS.....Philip J. Klass
CONGRESS.....Katherine Johnsen
MILITARY.....Claude O. Witze, Evert Clark
TRANSPORT....Craig Lewis, Glenn Garrison,
L. L. Doty
EQUIPMENT.....G. L. Christian
BUSINESS FLYING.....Erwin J. Bulban
ART EDITOR.....Lawrence J. Herb
ASST. ART EDITOR.....Robert G. Young
EDITORIAL PRODUCTION...Jerome E. Kelley
EDITORIAL ASSISTANTS
Bernie Lang, Betty Hein
LIBRARIAN.....Jeanne Rabstejnek

FOREIGN NEWS SERVICE

EDITOR.....John Wilhelm
LONDON.....William J. Coughlin
PARIS.....Robert E. Farrell
BONN.....Gerald W. Schroder
MEXICO CITY.....John H. Kearny
RIO DE JANEIRO.....Peter Weaver
TOKYO.....Dan Kurzman

DOMESTIC NEWS BUREAUS

ATLANTA 3.....801 Rhodes-Haverty Bldg.
CHICAGO 11.....520 N. Michigan Ave.
CLEVELAND 15.....1510 Hanna Bldg.
DETROIT 26.....856 Penobscot Bldg.
HOUSTON 25.....1303 Prudential Bldg.
LOS ANGELES 17.....1125 West Sixth St.
SAN FRANCISCO 4.....68 Post St.
WASHINGTON 4...1189 National Press Bldg.

SALES

ADVERTISING SALES MANAGER
E. P. Blanchard, Jr.
PROMOTION and RESEARCH MANAGER
W. H. Jack
ATLANTA.....R. H. Powell
BOSTON.....A. C. Boughton
CHICAGO and ST. LOUIS.....J. S. Costello,
F. E. Bauman
CLEVELAND.....H. P. Johnson
DALLAS.....Gordon Jones, Douglas Billian
DETROIT.....C. A. Ransdell
LOS ANGELES.....C. F. McReynolds,
D. T. Brennan
NEW YORK.....M. J. Storz
PHILADELPHIA....W. S. Hessey, J. D. Willis
SAN FRANCISCO.....William Woolston

BUSINESS

BUSINESS MANAGER.....J. G. Johnson
PRODUCTION MANAGER.....W. V. Cockren

RESEARCH AND MARKETING
Mary Whitney Fenton, Joan Read

Douglas DC-9 Performance Is Revealed..... 26
► Top cruising speed is 503 kts. at 30,000 ft., payload 21,340 lb., range 2,425 nautical miles.

Airlines Demand 'Practical' Helicopters..... 38
► Air Transport Assn. challenges industry to meet promises, provide profitable commercial rotorcraft.

Scientists Tackle Jet Noise Problem..... 50
► Slit exhaust is best suppressor, but all methods mean appreciable thrust loss.

MISSILE ENGINEERING

Snark is Airlifted..... 29
New Photograph of Petrel..... 30
Demon Carries Sparrow..... 31

AERONAUTICAL ENGINEERING

C-130 Shows off Climb..... 27
Curtiss-Wright Orders Water Loop.... 30
Bombing Etches Firepower Patterns... 32
NAA Plans Jet Transport..... 41
Soviet Training Well Integrated..... 58
Forecast of Czech Copter..... 79

EQUIPMENT

Vulcan 20 mm. Cannon Bows..... 30
Voodoo Tests Camera..... 37
Parachuting Behind Iron Curtain..... 71

BUSINESS FLYING

Market for 600 M-185s.....100
Aeroflot Yak-12 Handles Utility Role..101
Private Lines 102

TRANSPORT

Airline Pilots Cut From Reserve..... 39
North Atlantic Traffic Falls Short..... 40
Airways Construction Program..... 40
Tacan/DME Chosen for Airways..... 41
Pacific Flight Pattern Revised..... 43
Bermuda Fare Action Postponed..... 43
Shortlines 47
Airline Observer 47

FINANCIAL

Electra Expense Holds Down Earnings. 34
Stock Transactions 103

AVIONICS

Space Navigation Challenge..... 82

MANAGEMENT

Cook Considered for AIA Head..... 27
Defense Aircraft, Missile Contracts... 29
Douglas, Lockheed Decline AIA Bid... 30
Who's Where 23
Industry Observer 23
Washington Roundup 25
News Digest 34

Calendar 5
Letters 118

EDITORIAL

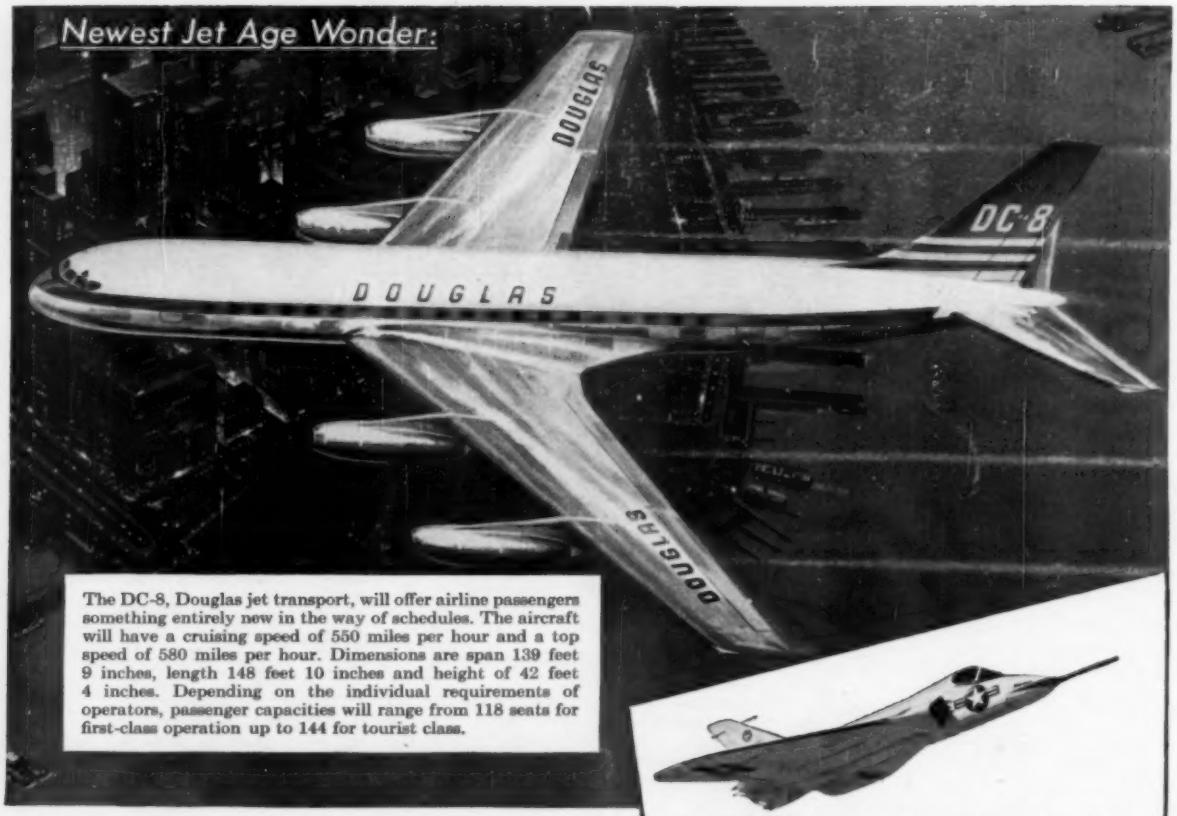
Scramble for Florida's Coconuts..... 21

COVER: Cmdr. Robert W. (Duke) Windsor wears a pleased smile standing in the cockpit of the Chance Vought F8U Crusader in which he made an official speed run of more than 1,000 mph. The run, made at the Naval Ordnance Test Station, China Lake, Calif., won the 1956 Thompson Trophy. Though capable of challenging the British-held speed record of 1,132 mph. set by the Fairey Delta FD2, the F8U was held below its top performance on Defense Department orders. The Thompson Trophy was awarded to the Navy at the National Aircraft Show.

Picture Credits:
41—Howard Levy; 71—Sovfoto.

66,648 copies of this issue printed

AVIATION WEEK • SEPTEMBER 3, 1956 • Vol. 65, No. 10
Member ABP and ABC



The DC-8, Douglas jet transport, will offer airline passengers something entirely new in the way of schedules. The aircraft will have a cruising speed of 550 miles per hour and a top speed of 580 miles per hour. Dimensions are span 139 feet 9 inches, length 148 feet 10 inches and height of 42 feet 4 inches. Depending on the individual requirements of operators, passenger capacities will range from 118 seats for first-class operation up to 144 for tourist class.

New Douglas DC-8

JET TRANSPORT

brings super speeds to civilian flight

The newest Douglas contribution to the jet age, the new DC-8 is destined to make radical changes in intercontinental scheduling of civilian flights. Macwhyte "Hi-Fatigue" control cable is utilized for the control installations in the new DC-8. Indeed, all three Douglas plants in Southern California—Santa Monica, El Segundo, and Long Beach —use Macwhyte cable for installation on planes like those shown on this page.

The F4D is designed to climb quickly to high altitude and destroy enemy aircraft before they can attack a vital target. The delta-wing Navy speedster has a span of 33 feet 6 inches, length of 45 feet 8 inches and a height of 13 feet. It is powered by a Pratt & Whitney J57 engine. It set the world's official air speed record (3 km. course) on October 3, 1953 with a mark of 752.9 mph. Two weeks later it broke the 100 km. closed course record with a speed of 728.11 mph.

The RB-66, reconnaissance version of the B-66 bomber, is an aircraft of the 600-700 mile per hour class. This latest addition to the Air Force tactical reconnaissance capability has a span of 72 feet 6 inches, length of 75 feet 2 inches and a height of 23 feet 7 inches. It is powered by two Allison J71 engines.

Because it is properly PREformed, "Hi-Fatigue" cable lies dead with no tendency to twist or curl. Assemblies can be made to closer tolerances, and there is minimum uniform stretch in any length. Macwhyte makes a complete line of sizes and types of "Hi-Fatigue" aircraft control cable in Galvanized, Tinned, and Stainless Steel. Macwhyte aircraft products meet the requirements of aircraft manufacturers, air lines, and military specifications.

Aircraft Catalog A-3 free on request.

MACWHYTE

CABLE · TERMINALS · ASSEMBLIES · TIE-RODS

2905 Fourteenth Avenue, Kenosha, Wisconsin

Manufacturers of "Hi-Fatigue" Aircraft Cable—"Safe-Lock" Cable Terminals—Cable Assemblies—Tie Rods—Braided Wire Rope Slings—Bright, Galvanized, Stainless Steel, and Monel Metal and Plastic Coated Wire Rope.

MILL DEPOTS:

New York 4, 35 Water St.
Pittsburgh 19, 704 Second Ave.
Chicago 6, 228 So. Desplaines St.
Detroit 3, 75 Oakman Blvd.
St. Paul 14, 2356 Hampden Ave.
Ft. Worth 1, P.O. Box 605
Portland 9, 1603 N.W. 14th Ave.
Seattle 4, 87 Holgate St.
San Francisco 7, 188 King St.
Los Angeles 21, 2035 Sacramento St.

1101 A

EDITORIAL

Scramble for Florida's Coconuts

The question of providing more service linking the lush airlines traffic pools of the Northeast and Midwest with Florida has stirred some interesting controversy. It also has raised a number of problems that are fundamental to the new era of airline operations as a highly-competitive mass transportation business.

Northeast Airlines has come up with the biggest plum to date from the Florida service cases with its recent CAB award of the route to link its New York and New England points with Florida (AW Aug. 20, p. 38). Apparently, one of the major considerations in the Board's 3-to-2 vote for Northeast in the face of a CAB examiner's recommendation favoring Delta was the opportunity to get Northeast off federal subsidy. It is certainly in the public interest to get all airlines off public subsidy as soon as possible. But there also is another issue at stake—providing the public with adequate air service to the rapidly expanding Florida market.

What Can Northeast Provide?

Both Eastern Air Lines and National Airlines, now serving the New York-Miami run, are doing an adequate job. But the growing volume of traffic justifies adding at least another carrier and possibly more. During 1955, the New York-Miami run alone served about 763,000 passengers as compared with about 591,000 on the New York-Chicago run. Yet, there are only two competitors to Miami and five to Chicago from New York.

Just how much additional service Northeast will be able to provide is a question the Board hopes to have answered by 1961. Northeast will face an acute equipment problem, even with the 10 DC-6B transports on order, in the face of the DC-7 fleets of Eastern and National.

Extremely strong cases were presented by other main contenders for the Miami market. Capital was disregarded by the CAB examiner largely because he opined that its Viscounts would not be suitable for the route. Capital has since bought a fleet of Comet IV turbojet transports that would be ideal for this route. Capital still has a chance to break into the Florida market in the Great Lakes-Southeast case where the Comet purchase should strengthen its hand.

Delta, strongly recommended by the CAB examiner, has a DC-7 fleet already operating and has good medium-range jet transports on order. Delta needed only a new 80-mile link to connect its current routes into a New York-Miami route. However, it has benefited greatly from earlier CAB route awards and no doubt suffered because of the Board majority philosophy of trying to transform all the former regional carriers into strong, subsidy-free trunklines.

Pan American's Bid

Perhaps the strongest technical case was presented by Pan American World Airways. It already has established major operating bases in New York and Miami, has a wealth of modern equipment that could be diverted from the North Atlantic summer season to the Miami winter boom, and it has been deadheading a considerable volume of equipment between New York and its overhaul base in Miami. Since U. S. domestic airlines have been put into the international business, there is no longer any logical reason why Pan American should be barred from domestic routes. Just which routes Pan American should be allowed to serve domestically is a moot point. But none fit more logically into its present operating pattern than the New York-Miami link.

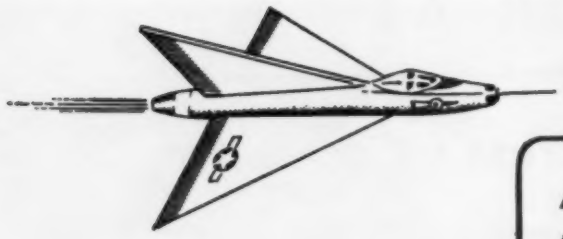
In its recent decision in favor of Northeast, the Board appears to be following the trend established by the majority headed by former chairman Ross Rizley of increasing competition, strengthening regional carriers and trying to get all of the major airlines off federal subsidy. These are sound objectives that should serve both the taxpaying and traveling public better, although there will be endless argument over the details the Board chose to achieve these broad goals.

Competition Swells Market

Post-war history has proved that the demand for low-cost air travel has exceeded all forecasts and that increased competitive service, combined with lower fares, swells rather than dilutes the market.

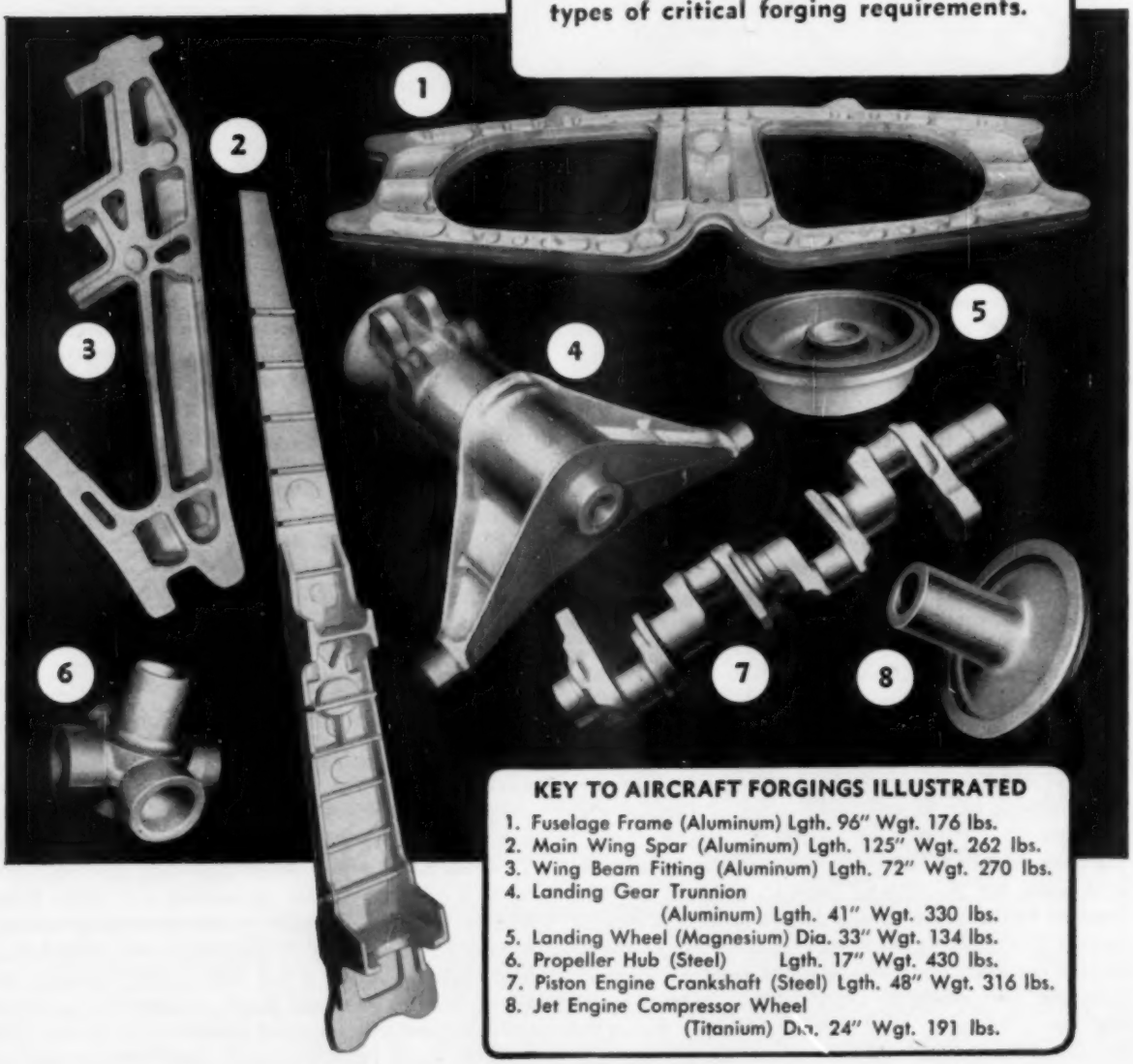
Florida is one of the fastest expanding markets in the country with its pension population and resort boom boosted by solid industrial growth, particularly in engineering and electronics. It deserves a new, expanded air traffic pattern linking it not only to the Northeast but also to the Midwest and Pacific Coast with the fastest and most modern transport equipment available. Not until the Great Lakes Case is decided by the Board and the question of better service to the West Coast is answered, will the proposed Florida traffic pattern be complete. The airline industry and the traveling public are watching with considerable interest the Board's action on Florida service. If the Board's proposals prove to be inadequate, it can expect vociferous reaction from the airlines and communities who are disappointed with its decisions.

—Robert Hotz



DEPENDABILITY...

Aviation engineers and designers since the beginning of the Aircraft Industry have relied on Wyman-Gordon for all types of critical forging requirements.



KEY TO AIRCRAFT FORGINGS ILLUSTRATED

1. Fuselage Frame (Aluminum) Lgth. 96" Wgt. 176 lbs.
2. Main Wing Spar (Aluminum) Lgth. 125" Wgt. 262 lbs.
3. Wing Beam Fitting (Aluminum) Lgth. 72" Wgt. 270 lbs.
4. Landing Gear Trunnion (Aluminum) Lgth. 41" Wgt. 330 lbs.
5. Landing Wheel (Magnesium) Dia. 33" Wgt. 134 lbs.
6. Propeller Hub (Steel) Lgth. 17" Wgt. 430 lbs.
7. Piston Engine Crankshaft (Steel) Lgth. 48" Wgt. 316 lbs.
8. Jet Engine Compressor Wheel (Titanium) Dia. 24" Wgt. 191 lbs.

WYMAN-GORDON COMPANY

Established 1883

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL • TITANIUM

WORCESTER 1, MASSACHUSETTS

HARVEY, ILLINOIS • DETROIT, MICHIGAN

WHO'S WHERE

In the Front Office

Frank W. Godsey, Jr., president, Air Associates, Inc., Teterboro, N. J., replacing **J. E. Ashman**, now president of Ultrasonic Corp., Cambridge, Mass. Mr. Godsey formerly was general manager, Westinghouse Electric Corp.'s Air Arm, Electronics and Defense Products Divisions.

H. Chapman Rose of Jones, Day, Cockley and Reavis, Cleveland, a director, Clevite Corp., Cleveland, Ohio.

H. A. Todd, president of Wisconsin Motor Corp., Milwaukee, and **Robert P. Brooks, Jr.**, vice president of Trundle Consultants, Inc., Cleveland, directors, Continental Aviation and Engineering Corp., Detroit, Mich.

Donald S. Smith, president, newly-formed Hupp International, a division of Hupp Corp., Cleveland, Ohio.

A. King McCord, president, Westinghouse Air Brake Co., Pittsburgh, Pa. Mr. McCord succeeds **E. O. Boshell** who has been serving as board chairman and president; Mr. Boshell remains as board chairman.

W. W. Valentine, president, Sequoia Process Corp., Redwood City, Calif. **Beardsley Graham**, executive vice president, elected a director.

Honors and Elections

David Roller, former airman and now civilian attached to Wright Air Development Center, won the Charles J. Cleary Award for 1955. The award is presented annually to the project engineer who, through original work, makes the outstanding contribution to the WADC Materials Laboratory technical program.

Dr. Richard Filipowsky of Westinghouse Electric Corp.'s electronics division will receive The British Institution of Radio Engineers' Heinrich Hertz Premium in recognition of his technical paper, "Electrical Pulse Communication Systems."

Changes

Brooks Honeycutt, assistant director-public relations, Allison Division of General Motors Corp., Indianapolis, Ind.

R. M. Rummel, sales-public relations administrative assistant, United Air Lines. **W. M. O'Hern** replaces Mr. Rummel as director of publicity. Also: **R. A. Young**, design manager, newly-created Facilities and Property Dept.

John O. McReynolds, manufacturing manager, TelAutograph Corp., Los Angeles, Calif.

Burns R. Maus, aviation sales manager, Champion Spark Plug Co., Toledo, Ohio.

Carroll P. Krupp, manager-product development, Aviation Products Division, B. F. Goodrich Co., Akron, Ohio.

C. E. Heimstadt, plant superintendent, Weber Aircraft Corp., Burbank, Calif.

Richard F. Howe, supervisor-experimental manufacturing, Research and Advanced Development Division, Avco Manufacturing Corp., Stratford, Conn.

INDUSTRY OBSERVER

► Mocked up test stand at Edwards AFB Rocket Base designed to simulate performance of engine, tankage and other components of Convair's Atlas intercontinental ballistic missile is scheduled to begin firings in approximately one week. Other Edwards test stands will simulate the Douglas Thor intermediate-range ballistic missile and North American's Navaho intercontinental missile.

► **Second control facility for the Atlas missile will be constructed for USAF at San Salvador Auxiliary AFB, British West Indies.**

► General Electric has developed experimental avionic components, including tubes, resistors, capacitors, transformers and motors, capable of operating at temperatures up to 500C. Lack of such high-temperature components already is being felt in intercontinental ballistic missile and aircraft nuclear propulsion programs.

► **North American F-107 fighter was scheduled to begin its flight-test program last week at Edwards AFB. Beginning of program was delayed because of hydraulic troubles. In speed, the aircraft is comparable to Republic's F-105.**

► Martin is developing a new four-engine flying boat for anti-submarine and rescue operations. Designation for the Navy aircraft, which will be powered by reciprocating engines, probably will be the P7M.

► **Air Defense Command interceptor versions of the Lockheed F-104A Starfighter will be approximately 200 lb. heavier than the standard day-fighter version scheduled to go to the Tactical Air Command. Under present plans, first F-104As will go to the Defense Command. The aircraft, carrying all-weather gear, will be used on long-range intercept missions.**

► Convair F-102B has been redesignated the F-106A. Primary difference between F-106A and its predecessor F-102A is the change from Pratt & Whitney J57 to Pratt & Whitney J75 powerplant.

► **Vertol Aircraft Corp.'s entry in the Navy utility helicopter competition is the HUP-5, a turbine-powered version of the HUP-2.**

► Bell Rascal missile test program has produced an increasing degree of accuracy and reliability for the rocket-powered air-to-surface missile.

► **Lockheed F-104 flew from Palmdale, Calif., to Albuquerque, N. M., 660 air miles away in one hr., 5 mins. on way to National Aircraft Show in Oklahoma City. Aircraft, piloted by Maj. Stuart Childs, of Edwards AFB, was not pushed.**

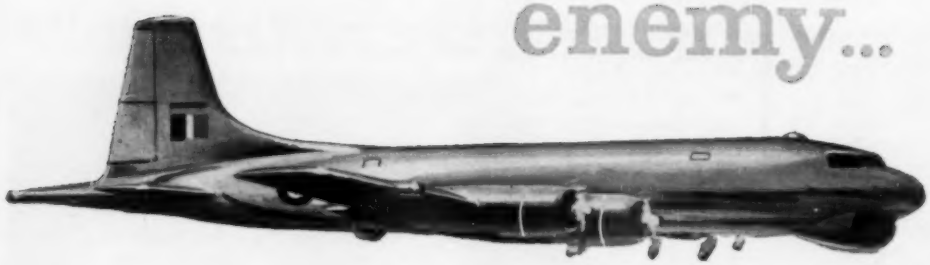
► Army is sponsoring a competition for a 400-mph.-plus turboprop reconnaissance lightplane. Powerplant will be under 1,000 hp.

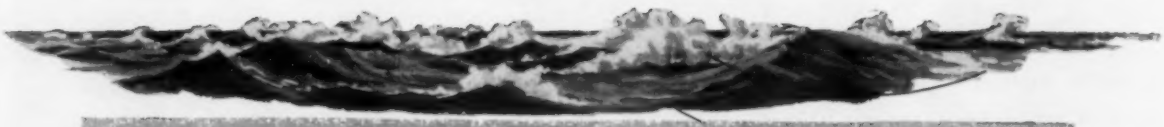
► **First large-tail versions of Convair's F-102A delta-winged interceptor have been delivered to the 11th Fighter Interceptor Squadron based at Duluth, Minn.**

► Fairchild has launched a new division, tentative called "Operations Research," to investigate new product possibilities brought about by the changing character of military organizations. Central activity at present is with the Army but will eventually extend to all three services. Present emphasis is on lighter equipment for airborne operations. Office of new unit is in Arlington, Va.

► **Major U. S. helicopter manufacturers had total sales of $141,703,000 during the first six months of the year. Military sales accounted for $119,732,000; civilian sales for $21,971,000. The civilian sales increased to $14,079,000 in the second quarter after sales of $7,892,000 in the first quarter.**

To seek the hidden enemy...





Soon, the oceans around Canada will be patrolled by the first aircraft developed specifically for Canadian maritime reconnaissance duties . . . the Canadair-designed CL-28.

Developed from the Bristol Britannia class by Canadair, this is the largest aircraft ever to be manufactured in Canada and we at Canadair regard it as a tribute to our capabilities that the RCAF selected us to do the job.

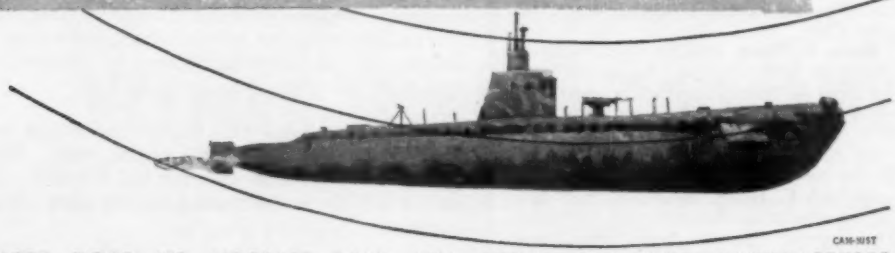
Size, of course, is not the only factor, for we are equally at home in the design and production of jet fighters, training planes, airliners, guided missiles or even components for other aircraft. What counts most is our outstanding record for cost performance, on-time deliveries and quality of manufacture.

C-L CANADAIR

LIMITED, MONTREAL, CANADA

AIRCRAFT MANUFACTURERS

A subsidiary of GENERAL DYNAMICS CORPORATION, New York, N.Y.—Washington, D.C.



CAN-1157

CANADAIR HAS PRODUCED MORE JET AIRCRAFT THAN ANY OTHER CANADIAN MANUFACTURER

Washington Roundup

Democratic Challenge

The Democratic National Committee has unearthed Congressional testimony by top USAF, Navy and Army officers in a campaign-year effort to refute Republican Party platform planks defending the administration's defense program over the past three years.

These are the Republican planks and the Democratic comments:

• **Republican:** "We have the strongest striking force in the world . . . which must continue to include (A) a jet-powered, long-range Strategic Air Force and a Tactical Air Force with a striking capability superior to any other; (B) the most effective guided and ballistic missiles, and (C) a modern Navy with a powerful naval aircraft arm prepared to keep the sea lanes open to meet any assignment; (D) an Army whose mobility and unit fire power are without equal."

• **Democratic comments:** "(A) Air Force Vice Chief of Staff Gen. Thomas D. White has said that 'in airplane after airplane they (the Communists) are approaching us in quality and surpassing us in quantity' and Air Force Chief of Staff Gen. Nathan Twining told a Senate committee that 'it is in quality that we have been able to stay ahead. However, the Soviets are now closing the quality gap.' (B) Russia has already tested an 800-mile guided missile. The maximum range of our Redstone missile is 200 miles; it is reliably reported that Russia will test a 1,500-mile missile by the end of the year; the U. S. has only recently launched a crash program to catch up with the Russians in long-range missile development, but, according to the former Assistant Secretary of the Air Force Trevor Gardner, the program is bogged down in administrative red tape. (C) Vice Adm. Robert P. Briscoe, Deputy Chief of Naval Operations, says the Russian Navy will surpass ours by 1958 unless we embark on an elaborate building program. (D) Gen. Matthew B. Ridgway says that at the time of his resignation as Chief of Staff 'no adequate mobile, ready force was in being'."

• **Republican:** "We have supported and will continue to support an effective and well-directed program of research and development."

• **Democratic comment:** "Lt. Gen. Donald Putt, head of USAF's research and development program, has testified that since 1953, funds needed for USAF research and development programs have been 'inadequate'."

• **Republican:** "In this age of weapons of inconceivable destructiveness, we must not neglect the protection of the civilian population by all known means, while at the same time preparing our armed forces for every eventuality."

• **Democratic comment:** "Gen. Earle E. Partridge, head of our Continental Air Defense Command, told a Senate committee in 1956 that if a Russian air attack were launched against us today most of the bombers would get through, stating 'I do not think our defenses are good enough'."

Public Relations Problems

Confidential memo has been circulating among top-level aircraft industry public relations directors suggesting exploration of other methods of handling the Aircraft Industries Assn. public relations program than the current contract with Hill & Knowlton public relations agency.

Memo was authored by one of the top industry public relations experts and has been circulated only among the public relations directors of a few large aircraft firms whose presidents are key figures in the direction of AIA. At the AIA Board of Governors meeting in Williamsburg, Va., last spring, a substantial increase was voted in the Hill & Knowlton budget for the AIA program and several additions have been made to the agency staff in Washington as a result.

Less Manpower for D. C.

Without fanfare, the Defense Department has issued new instructions ordering the military services to cut back on personnel in the Washington area. The policy is to reduce the payroll to the lowest point possible, while still maintaining a capability to do the job.

Secretaries of Army, Navy and Air Force have been ordered to implement the policy, and without resorting to the use of temporary duty or change of definitions to sidestep its intent. Monthly reports must be made to show the number of military and civilian personnel on the job every 30 days.

Pentagon Breather

Pressure of Congressional campaigns will give Pentagon officials a breather before being called before the House Information Subcommittee to continue testimony on public information and secrecy policies and practices. Although the subcommittee considers the Defense Department most important of all government agencies in its inquiry, it has abandoned plans to conclude hearings late this month.

Members want to concentrate on trying to get re-elected. Regardless of whether they're successful, the hearings will be completed sometime between election day and the first of the year. Subcommittee Chairman is Rep. John E. Moss (D.-Calif.). Members are Reps. Dante Fascell (D.-Fla.) and Clare Hoffman (R.-Mich.).

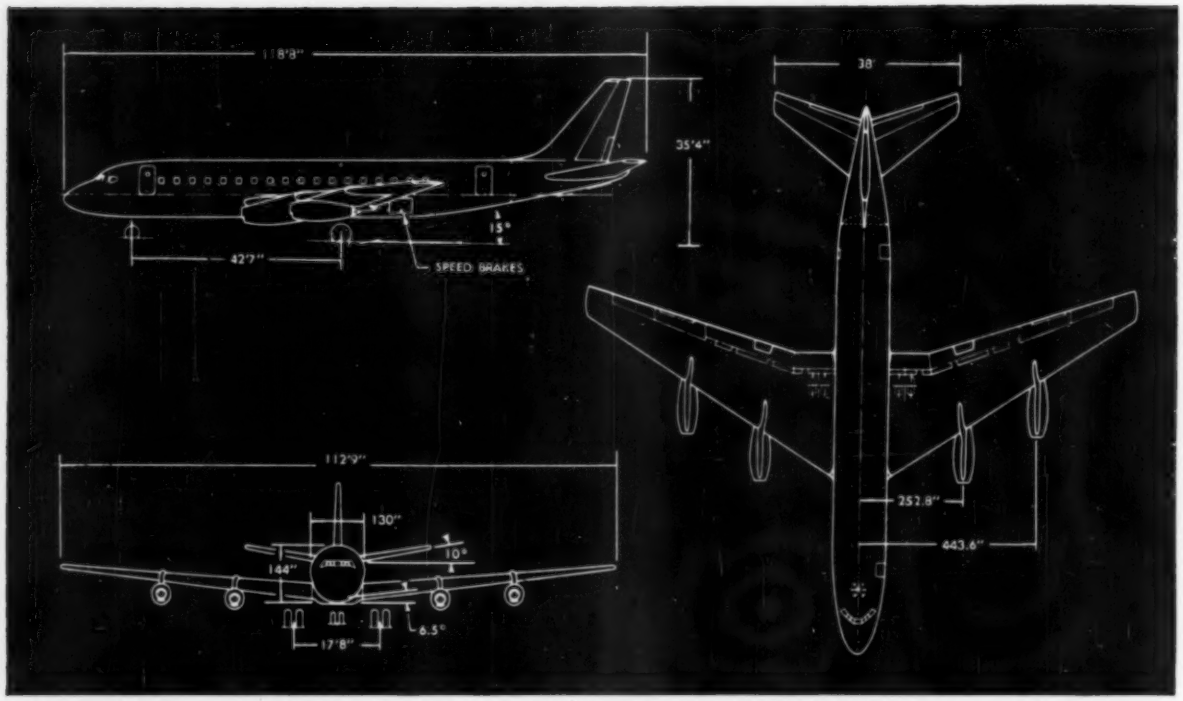
Nike-Talos Evaluation

Now it can be told: Direct result of the "Revolt of the Colonels" and Pentagon jurisdictional dispute over development and control of anti-aircraft missiles was the appointment of a committee to weigh relative merits of Army's Nike and Navy-USAF Talos. Following Defense Secretary Wilson's "united Pentagon front" press conference (AW May 28, p. 26), Eger V. Murphree, his special assistant for guided missiles, was made chairman of the new group to resolve the interservice controversy. Defense Department says review will be limited to scientific evaluation and not include a duel between the two missiles, as demanded by a Senate committee.

Co-pilot for S-58?

Civil Aeronautics Administration was asked last week to make a co-pilot mandatory in airline operation of Sikorsky's new S-58 helicopter. The request came from Air Line Pilots Assn. President Clarence N. Sayen who told the CAA that say one-man operation of the S-58 "would present a potential hazard" because of the complexities of the new helicopter.

The CAA already has certificated the S-58 from an engineering standpoint, but a decision on crew requirements will be included in the operating certificate issued to New York Airways, which plans to start flying the helicopter sometime this month. CAA will decide whether the S-58 needs a co-pilot after studying the NYA route qualification trials. —Washington staff



DOUGLAS DC-9 three-view drawing shows exterior is nearly identical to that of the DC-8. Dimensions are those of DC-8 reduced to roughly .8 scale. Dual wheel main gear differs from the quads used in the larger airplane.

Douglas DC-9 Performance Is Revealed

Top cruising speed is 503 kts. at 30,000 ft., payload is 21,340 lb., and range is 2,425 nautical miles.

Los Angeles—Douglas DC-9 medium-range jet transport has reached the point of a final design.

The DC-9 is intended to compete with the Convair 880 (AW June 18, 1956, p. 40). In general dimensions and features it appears to be a replica of the DC-8 drawn to approximately .8 scale. The 880 is somewhat larger, having a maximum gross weight of 173,500 lb. compared to the DC-9's 134,000 lb. maximum.

Convair has no big airplane comparable to the DC-8.

At 85% Power

Top cruising speed of the DC-9 will be 503 kts. at 30,000 ft. with a gross weight of 120,000 lb. using maximum cruise thrust which is 85% of normal rated power. The space limited payload has been set at 21,340 lb. of passengers and cargo.

Range will be 2,425 nautical miles with 37,500 lb. of fuel, take-off gross weight of 134,000 lb. and an average cruising speed of 483 kts. at 35,000 ft. Block speed ranges from 350 kts. for a stage of 300 nautical miles to 445 kts. for 1,000 nautical miles to 460 kts. for 3,000 nautical miles. Design level flight Mach number above 29,300 ft. is 0.88.

Powerplant Choice

Power for the DC-9 will be supplied by four split-compressor Pratt & Whitney JT8 turbojet engines, rated at 7,500 lb. thrust each. The engine is a commercial version of the Navy-developed J52 and was originally intended as a low specific fuel consumption, small frontal area powerplant for fighters. The Convair 880 will use the 10,000 lb. thrust General Electric J79 turbojet engine.

Total usable fuel capacity of the DC-9 is set at 58,570 lb. For use with the JT8 engine, Douglas has specified JP-4 middle cut gasoline, MIL-F-5572 aviation gasoline and Pratt & Whitney's specification PWA 522 kerosene. Pratt & Whitney is now seeking approval from the American Society for Testing Materials (ASTM) for general use of PWA 522.

Landing field length specified for the DC-9 without thrust reversers by CAR 4B is 5,550 ft. on a sea level airport with a landing weight of 105,000 lb. Douglas has made no claim regarding landing field length with reversers. Reverse thrust must be equal to 40% of net forward thrust to meet company requirements.

Each reverser will weigh 100 lb. Noise suppressors will be used which weigh 35 lb. apiece.

As in the DC-8 and the Boeing 707, (AW June 25, 1956, p. 63) two sets of ailerons will be used, one pair inboard and one outboard. The inboard ailerons are very small and give adequate control only at high speeds. The larger outboard ailerons are controlled through a pre-loaded spring linkage. At high speeds, the spring linkage yields to

New Boeing Transport

Boeing Airplane Co. will soon announce its entry into the small jet transport field with a number of firm orders for a smaller version of the 707.

The aircraft probably will be fitted with the General Electric CJ805, commercial version of the J79, or the Bristol Orpheus. Designed for short runways and with a range of 300 to 2,000 miles, the transport will be designed to have a top speed of over 600 mph.

high air load, and as speed increases it progressively washes out the effect of the outboard ailerons while retaining their effectiveness at low speeds. This is to avoid aileron reversal at high subsonic Mach numbers. The Boeing installation differs in that the outboard ailerons are driven by a linkage which is automatically broken when the flaps are retracted.

Wing Flap Spoilers

Like the bigger American jet transports, the DC-9 will have wing flap spoilers in the upper trailing edge of the wing to destroy lift as the airplane touches down in landings. A microswitch interlock in the nosewheel shock strut will prevent the use of the spoilers in the air. They are not intended to provide lateral control as are those of the Boeing 707. Speed brakes are located in the wing root fillets.

Instrument panel on the DC-9 is expected to comply generally with Aeronautical Standard 278 of the Society of Automotive Engineers' S-7 Committee on Cockpit Standardization.

The weather radar used in the DC-9 will probably be an advanced version of RCA's AVQ-10 with a storage tube presentation to provide a trace bright enough to be read easily in daylight without the aid of a hood.

In its present design stage, the new airplane has seats for 74 passengers four abreast. As usual, final passenger capacity and accommodations will vary somewhat according to the wishes of buyers. A cabin altitude of 6,700 ft. at an airplane altitude of 40,000 ft. may be maintained by the cabin supercharger turbocompressors, which will be driven by engine compressor bleed air.

Orval Cook Considered As New Head for AIA

Washington—Orval Cook, retired USAF general and a materiel expert, is among the leading candidates being considered by the Aircraft Industries Assn. Board of Governors to replace Dewitt C. Ramsey as AIA president.

Gen. Cook, who was deputy USAF chief of staff for materiel, director of procurement for Air Materiel Command and commander of USAF logistics forces in Europe, recently retired with the rank of full general and is now living in Indiana.

Meanwhile, Gen. Joseph McNarney, president of Convair and AIA board chairman, confirmed AVIATION WEEK's exclusive story of August 27 revealing that an active hunt is on for a successor to Ramsey. In a statement prepared and distributed by Avery McBee, public relations director of AIA, Gen. McNarney said:

"The Board of Governors is completely satisfied with the strong leadership which Admiral D. C. Ramsey has given the Aircraft Industries Association during his term of president. Admiral Ramsey has devoted himself vigorously to a tremendous number of critical industry problems and has represented us in a highly capable and efficient manner.

"Admiral Ramsey has indicated that he does not plan to seek extension of his contract beyond its expiration date, July 1, 1958. This is based entirely on personal considerations involving his own health. Under those circumstances, our Board does not consider it is fair to request Admiral Ramsey to continue to carry his heavy burden of responsibility.

"As a consequence, a committee has been appointed by the Board of Governors of the Aircraft Industries Association to screen candidates for his successor. This committee has been active with the full knowledge and cooperation of Admiral Ramsey."

AIA staff sources admitted that whoever was selected for Ramsey's post probably would join the organization before the year's end, presumably as an executive assistant for a period before Ramsey's retirement. However, industry sources discounted the possibility of this procedure, indicating a man of the prestige and caliber being sought would only consider stepping directly into the presidency. Financial provisions would be made to cover the remainder of Ramsey's contract period.

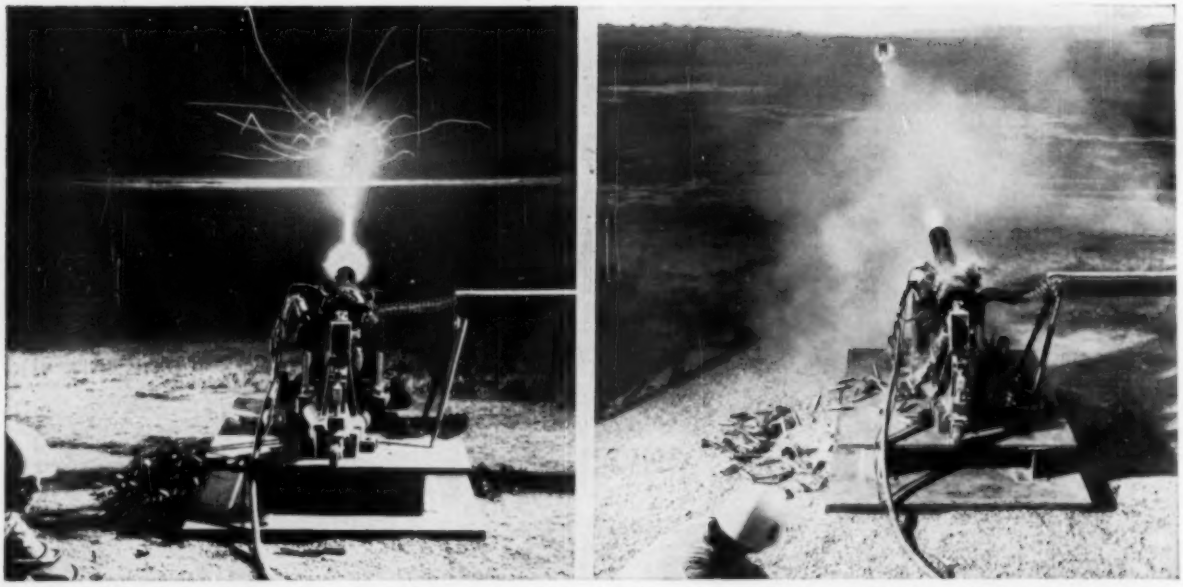
C-130 Demonstrates Climb

Steep climb after takeoff by a Lockheed C-130 Hercules turboprop transport is demonstrated for Maj. Gen. Alvord V. P. Anderson, Jr., commander of the Warner Robins Air Materiel Area, and his staff. The takeoff was made with the airplane loaded almost to its 108,000 lb. design weight. Specifications of the C-130 report a 25-30 deg. angle of climb on takeoff will bring the airplane to 2,500 ft. in 60 sec. (AW July 30, p. 72).

Convair-Astronautics General Contract Let

McNeil Construction Co. of Los Angeles will build the $40 million Convair-Astronautics facility east of San Diego (AW July 23, p. 58). Work will begin at once on the first phase, moving of 200,000 cu. yd. of earth.

Two connected six-story buildings for administration and engineering, a one-story plant building, and supporting facilities will be provided for Convair-Astronautics, which will develop, manufacture and do preliminary testing of the Atlas ballistic missile and related projects.



SINGLE BELT of electrically primed ammunition feeds all six barrels of General Electric Co.'s 20-mm. Vulcan aircraft cannon.

'Gatling Gun' Designed for F-104, F-105

By Evert Clark

Aberdeen Proving Ground, Md.—General Electric Co.'s new six-barrel 20-mm. Vulcan aircraft cannon that will arm F-104 and F-105 USAF fighters and B-58 supersonic bombers was officially unveiled here last week. Cyclic rate is around 7,000 rounds per minute.

First picture of the Vulcan appeared in AVIATION WEEK's Aug. 6 issue (p. 307).

Vulcan's high rate of fire and high firepower-to-weight ratio (50 lb. per barrel) result from application of principles first used 84 years ago in the Gatling machine gun. Fifty-caliber machine guns used in World War II planes fired at about 800 rounds per minute.

The Vulcan was developed for USAF by General Electric under Army Ordnance Corps supervision. Air Force designation is T-171. GE is now developing an aiming device for use with the Vulcan.

The six-barrel cluster is rotated counter-clockwise (looking from the breech end) by either external electric or hydraulic drive. Each barrel has its own bolt that holds the shell firmly from entry to ejection, virtually eliminating double feed, according to General Electric.

A single belt of electrically-primed ammunition feeds all barrels. Rounds are picked up at the 5 o'clock position, fired at 12 o'clock and ejected at the 7 o'clock position. Indications are that empty shells would be stored inside the aircraft until a mission is ended.

General Electric, the Army and the Air Research and Development Command's Air Force Armament Center at Eglin AFB, Fla., have put four models of the Vulcan through extensive tests. ARDC said that, after more than two years of testing, its project engineers found the Vulcan program "very reliable."

The Vulcan has been flown in an F-94 test aircraft at Eglin and has been tested in the Lockheed F-104.

Although no production contracts have been announced, General Electric said its production capacity will be 25 Vulcans a month by the end of this year.

What Vulcan Will Do

GE and USAF claim these advantages for the gun:

• **Superior dispersion** through barrel stability and reduced vibration. Clamping the six barrels rigidly together eliminates the "whip" of a single barrel, and firing one round at a time eliminates erratic recoil of a multiple-gun installation. Centralized recoil also eliminates turret oscillation.

• **Unprecedented reliability** due to external power supply. Each round is independent of the previously fired round, "dud" rounds are ejected automatically and cannot cause stoppages; the gun is inherently cleaner and less susceptible to corrosion than gas-actuated guns. The lower per-barrel rate of fire also means cooler operation.

• **Little maintenance is required.** Vulcan's rotary motion and reduced vibration mean longer life for parts and mounting. The gun can be field stripped for cleaning and maintenance and reassembled in less than 30 min. Complete disassembly and reassembly can be accomplished in less than half a day.

Details on range, muzzle velocity and exact rate of fire are still classified.

Vulcan Weight

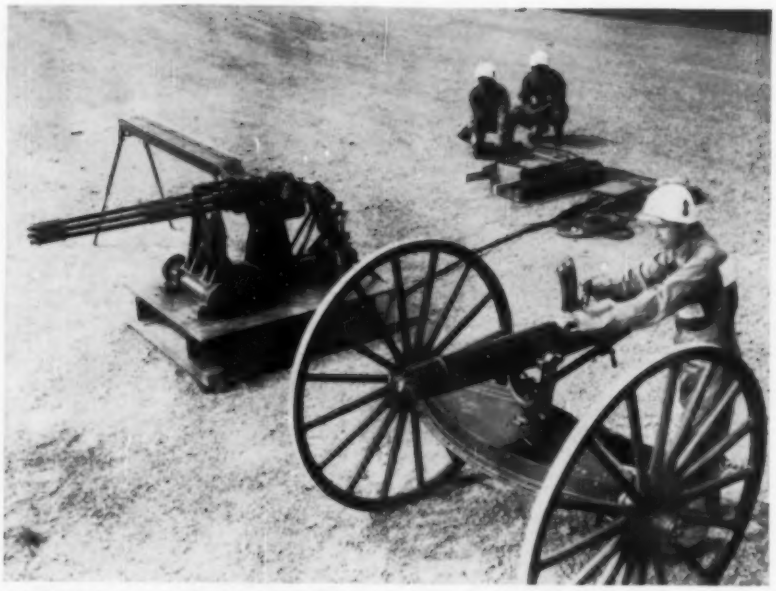
Weight is 290-300 lb. and length is 72 in. Model A had 779 parts; the present Model D has only 448. First models, designed for .60-caliber ammunition, weighed 71 lb. per barrel. Later models include several features not on the original model—a rounds counter actuator, booster take-off, gun-heater, feeder synchronization and gun clearing assembly.

General Electric said the Air Force concluded after low-temperature and high-altitude tests that the Vulcan operated as well at temperatures down to and including −67F as it did at room temperature when the gun heater is turned on at the appropriate time prior to firing. The tests also demonstrated that parts not heated prior to firing performed satisfactorily.

Standard lubricants are satisfactory and altitude conditions had no effect on firing or on functioning of the electrical connections, according to GE.

Another feature of the Vulcan is a half rate of fire for strafing.

Sanford Engineering Co. of Oxford, Conn., assisted General Electric in link design and Autowyre Works, Oakville,



VULCAN (left) and a 1903 model Gatling gun are demonstrated side by side.

Conn., assisted with link manufacture.

Development of the T-45, first of the Vulcan series, resulted from the Army Air Corps' realization in World War II that weight and rate of fire would be drastically altered by speeds of supersonic aircraft.

In 1946, General Electric's Aeronautics and Ordnance Systems Division at Schenectady, N. Y., was commissioned to develop an aircraft cannon under supervision of Ordnance Corps' Springfield Armory.

Army and General Electric engineers made a detailed study of every gun mechanism patented in this country and decided that Richard Jordan Gatling's multi-barrel machine gun principle, first patented in 1862, promised the best rate of fire.

The first Gatling was designed for .58-caliber ammunition. Later it was modified for both .50-caliber and 1-in. ammunition.

The 1903 Model Gatling used at the demonstration here for comparison to the Vulcan fired .303 ammunition. The Army did not declare the Gatling obsolete until 1911.

Although the barrel-cluster on the 1903 model was turned by a hand crank, Gatling received a patent in 1893 for an electric motor that was mounted in the rear of the gun casing and drove the gun at the-then fantastic rate of 3,000 rounds per minute.

In the F-104, the Vulcan probably will be fired through a gun port on the left side of the fuselage below the cockpit. In the Convair B-58 Hustler, the Vulcan presumably will be used in a flexible mount in the tail.

Defense Awards $5,335 Million Aircraft, Missile Contracts in '55

Washington—Aircraft and missile manufacturers were awarded $5,335 million in Defense Department contracts during 1955. The figure, announced last week, was 34.9% of all Pentagon procurement.

Topping the list of firms with military contracts was Boeing Airplane Co., manufacturer of the B-52 intercontinental jet bomber, with orders valued at $797.2 million, or 5.2% of the total.

Close second to Boeing was North American Aviation Inc., with $790.9 million, also calculated to be about 5.2% of the total. Third highest was General Dynamics Corp., which includes Convair. The corporation won $781.7 million in contracts, 5.1% of the total.

In the new list of 100 largest contract winners covering the last calendar year, General Motors Corp., long the top-ranking defense contractor, slipped to 14th place with $182.1 million, only 1.2% of the total awards. However, in a recapitulation for the five-and-a-half year period from July, 1950, to December, 1955, General Motors still ranks as the busiest contractor with 5.2% of all outstanding defense contracts. Boeing ranks second with 4.6%.

In a statement accompanying the lists, the Defense Department pointed out that the 1955 awards represent a more normal period of procurement than the years of the Korean buildup—1950 to 1953—and those of extensive cancellations—1953 to 1954.

The Department said there are factors that tend to increase the percentage of contracts awarded to some of the companies consistently among the top 100 contractors. These are:

- **Acquisition of subsidiaries** that also are prime military contractors. A total of 304 companies, including parent and subsidiary firms, were represented on the list as of December 1955, as compared with 240 as of June 1953.
- **Increasing emphasis on aircraft** and missiles. These products as a rule can be given only to large companies with the capability to act as prime contractor on complex projects.

Fourth-ranking corporation on the list of 1955 contract awards is United Aircraft, $587.4 million.

Others in the first ten are General Electric, $570.2 million; American Telephone and Telegraph, $505.3 million; Ford Motor, $472.2 million; Lockheed Aircraft, $412.7 million; Curtiss-Wright Corp., $354.7, and Douglas Aircraft, $291.1.

AF Transports Snark In Douglas C-124

Hawthorne, Calif.—U.S. Air Force transports its Snark SM-62 intercontinental guided missiles from the Northrop aircraft factory here to launching sites in standard Douglas Globemaster C-124 transports.

Snark can be airlifted in a matter of hours from Hawthorne to potential launching sites near any airfield in the world capable of receiving C-124 aircraft.

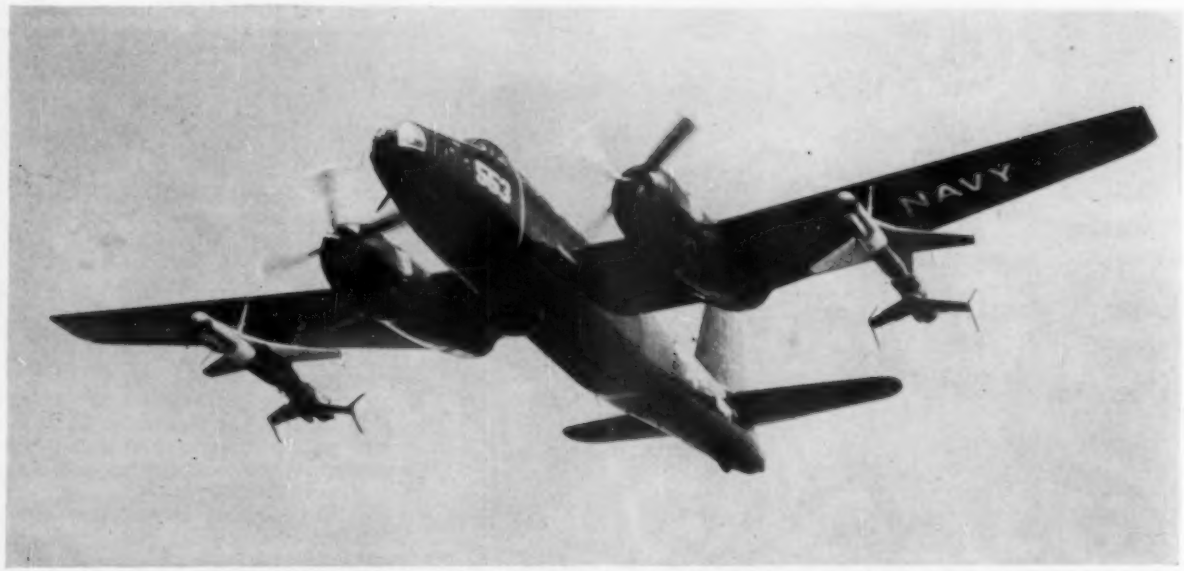
One of the Snark missiles arrived in Oklahoma City aboard a C-124 for display at the National Aircraft Show Sept. 1, 2 and 3.

Air Force has been using C-124 transports regularly in delivering Snark missiles to the Air Force Missile Test Center at Patrick Air Force Base, Fla.

Single C-124 transports a complete Snark. The fuselage is rolled aboard on its regular ground handling dolly. Wings and vertical tail fin are removed for stowage aboard the Globemaster.

Missiles are loaded for delivery at Northrop's flight facilities at Los Angeles International Airport. Field assembly of major components is accomplished rapidly once the Snark arrives at the launching site.

Snark, designed to deliver a nuclear warhead over intercontinental distances, is 74 ft. long, 42 ft. in wing span and 15 ft. high. It is now powered by a Pratt & Whitney J57 turbojet engine.



NEW PETREL details released by Navy confirm earlier Aviation Week estimates of 24-ft. length and 13-ft. wingspan (AW April 9, p. 33). Missile gross weight is 3,800 lb. It combines jettisonable airframe and J44 turbojet powerplant with a standard Navy airborne torpedo. Active homing system guides the Petrel to within normal torpedo range, where a radio altimeter gives the jettisoning signal. With airframe removed, the torpedo makes a normal drop and run-in to target. Launching is from a Lockheed P2V-6B Neptune capable of carrying two Petrels on underwing pylons. Navy says a number of aircraft are so equipped, and is planning to outfit squadrons for both Atlantic and Pacific fleets.

Curtiss-Wright Orders Water Loop

Garden City, N. Y.—Curtiss-Wright contract to design, build and operate a water loop test facility for nuclear research has been awarded Walter Kidde Nuclear Laboratories, Inc.

A water loop is a piping circuit in which the same fluid is recirculated to carry heat away from a certain point. In this case the laboratories are modifying a 50 ft. loop built four years ago for the Atomic Energy Commission. It is composed of an industrial-type pump and lagged piping from two to ten inches in diameter.

Wilbur E. Kelley, president of the laboratories, explained that water could be pumped around this circuit at fairly high velocities and pressures. A 4-ft. section of 2-in. pipe in one of the vertical legs of the circuit will be removed after check-out, he said, and in its place flow elements which Curtiss-Wright wants tested will be connected. The container for these elements will admit the necessary pressure and temperature taps for instrumentation.

Presumably the object of this loop is to test the cooling system which the laboratories are under contract to design for Curtiss-Wright's nuclear aircraft powerplant. They will investigate the heat transfer and the flutter of the system.

Another contract which Kidde has with Curtiss-Wright covers the design of a liquid metal loop for Curtiss-Wright's Quehanna, Pa., nuclear test facility. This could either be used independently or in conjunction with the swimming pool reactor planned for Quehanna.

The Kidde Laboratories which lack the size to compete with larger firms in major atomic programs, concentrate on handling nuclear problems on a consulting basis.

Besides the Curtiss-Wright water loop, the laboratories are designing a circulating water cooled test reactor for Pratt & Whitney and are studying nuclear power batteries for Elgin National Watch Co. In the nuclear airframe field the laboratories are doing work for Convair and Glenn L. Martin.

Douglas, Lockheed Decline AIA Miami Bid

Washington—Two major U.S. aircraft manufacturers have declined invitations to take part in the Aircraft Industries Assn.'s Latin American Aviation Conference in Miami, Nov. 14-16 (AW June 4, p. 37).

Neither Douglas Aircraft Co. nor Lockheed Aircraft Corp. will attend the meeting to discuss a co-ordinated military and commercial program covering present and future Latin American equipment needs.

Spokesmen for the two companies said their sales staffs have prior commitments and indicated in both cases that they have more important sales interests at this time. Two competitors of Douglas and Lockheed are active in laying plans for the Miami conference. They are Convair and Boeing Airplane Co.

Charles H. Shuff, of Westinghouse Electric International Corp. and chairman of the AIA Export Committee, said Latin American representatives at the session will tell about their problems. U.S. military and civilian aviation leaders will tell what can be provided to meet their needs. The conference will cover present and projected needs and availability of equipment for military and naval aviation.

Requirements for civil aviation products including transports, utility aircraft, helicopters, engines and major accessories also will be discussed.

No list of speakers for the meeting has been announced. The session originally was planned for last February but was postponed on orders from AIA President Dewitt C. Ramsey.

Curtiss-Wright Pilot Killed in F11F Crash

William M. Drake, 34, test pilot for Curtiss-Wright Corp., was killed at Edwards AFB, Calif., last week in the crash of a Grumman F11F.

The plane was undergoing routine afterburner tests when a flameout just prior to landing forced Drake to try and set the aircraft down in the desert short of the landing area. The aircraft is powered by the Wright J65 engine.

FOUR SPERRY SPARROW air-to-air missiles are mounted on missile carrying version of McDonnell Demon, designated F3H-2M, which went into operational service last month. Demon carries 20 mm. cannon as part of armament. The McDonnell all-weather fighter is powered by an Allison J71 engine.

USAF Service Centers Will Be Cut to Five

Three of the seven Flight Service Centers at Air Force bases in the United States will be eliminated and their operations will be taken over by the four other centers and a new one to be selected. The centers, which provide such services as transmitting flight plans and providing in-flight advisory service on request, are being reduced to provide more efficient, consolidated operation.

The March AFB, Calif, Center will close early in October and the Hamilton AFB center will take over its area of responsibility.

Centers at Wright-Patterson AFB, Ohio, and Lowry AFB, Col., will be closed and the new center at a base not yet designated will take over their areas in 12 to 18 months.

Defense Asks Copter Instrument Solution

Helicopter instrument flight is one of six problems thrown out for solution to the nation's inventors by the Department of Defense through the National Inventors Council of the Department of Commerce.

The problems, cited as currently limiting the effective operation of Army helicopters, are:

• **Vibration level detector,** to measure and present a continuous recording of critical vibration levels to crewmen.

• **Helicopter instrument flight,** including the instruments, techniques and aids to permit the rotary-wing craft to operate in minimum conditions equivalent to those now flown by fixed-wing planes.

• **Rotor blade stall indicator,** to measure and present a continuous recording of the blade stall on the retreating blade.

• **Coating for skis** or ski-type landing gear, to have a low coefficient of friction on dirt and clay, excellent abrasion resistance, good adhesion to wood or metal, and which will not freeze to ice, absorb moisture, rot or deteriorate.

• **Electronic** stethescope for gear components in action, for comparing sounds given off by worn parts, such as bearings or gears, with the normal sound of new parts.

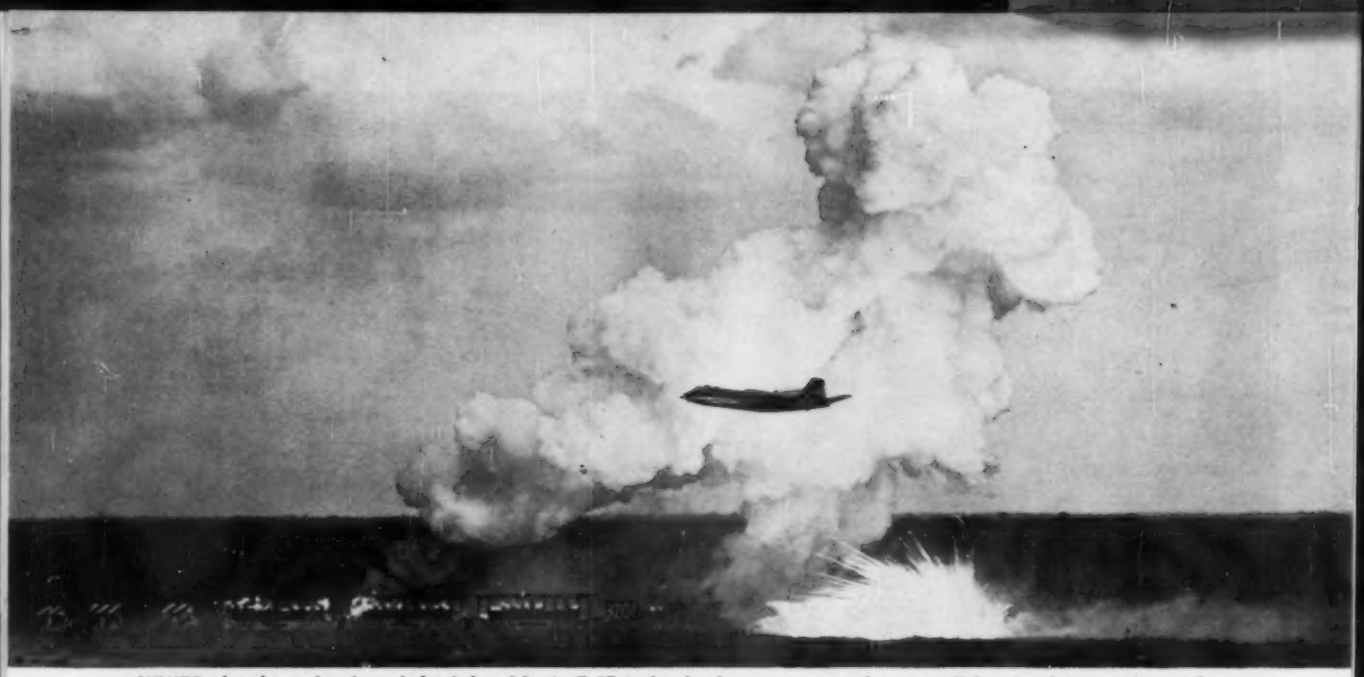
• **Metal-to-metal bond** inspection technique, for checking structural joints.

Further information can be obtained from the council, Washington 25, D.C.

Propeller Shipments

Plants manufacturing complete aircraft propellers shipped propellers and parts valued at $57.4 million during the first half of 1956, according to the Bureau of Census and the Civil Aeronautics Administration. The shipments represent an 8% decrease over the same period of 1955. Figures listed below under other products and services include experimental and developmental work by companies manufacturing complete aircraft propellers:

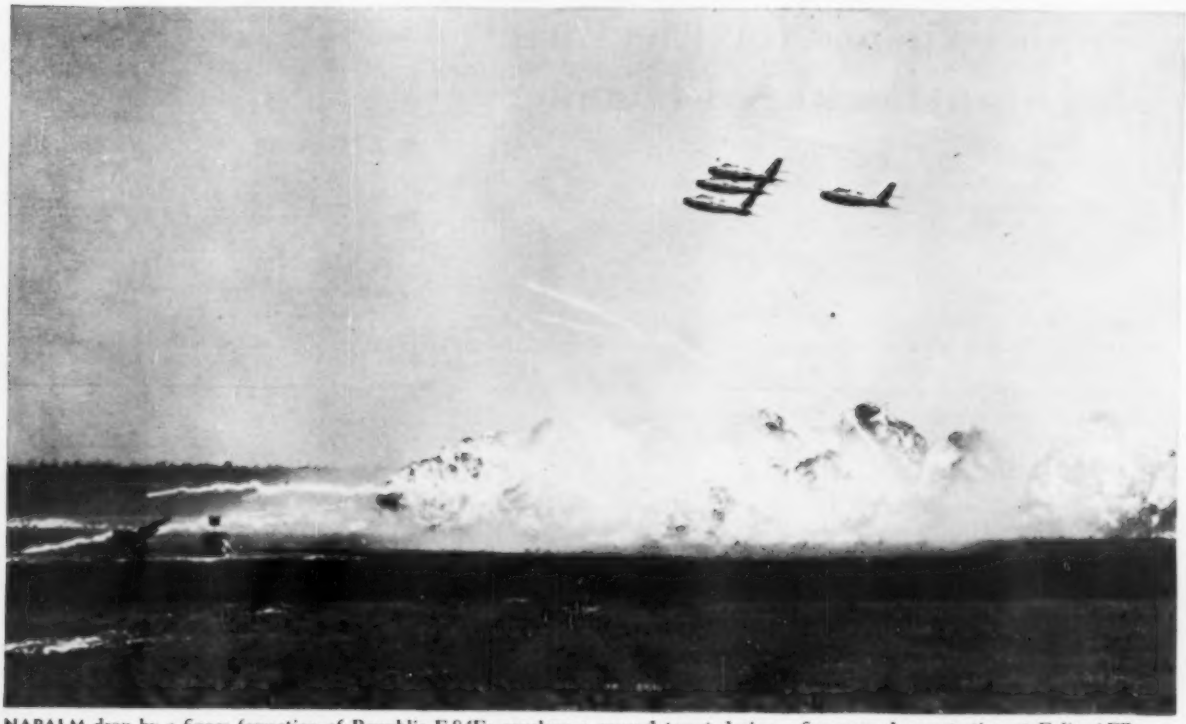
Period	Value of All Products Total	For Military	For Civilian	Other Products and Services
	(000 Omitted)			
1956				
1st Quarter	$40,343	$21,520	$6,430	$12,393
2nd Quarter	45,014	21,639	7,837	15,538
1955				
1st Quarter	41,121	26,246	5,269	9,606
2nd Quarter	40,757	25,827	4,964	9,966
3rd Quarter	34,222	21,830	3,601	8,791
4th Quarter	44,431	28,004	4,293	12,134



WHITE phosphorus bomb explodes below Martin B-57 in low-level run over ground target still burning from previous strike.

LAB SYSTEM used by F-100 (left) is technique for bomb-tossing during low-level dash to target, is used with atomic weapons.

Toss Bombing,



NAPALM drop by a finger formation of Republic F-84Fs envelops a ground target during a firepower demonstration at Eglin AFB.

Napalm, Phosphorus Etch Firepower Patterns

ON THE DECK, a tight formation of eight F-84Fs salvos napalm against target of buildings and old automobiles.

Research Expense for Electra Holds Down Lockheed Earning

Research and development expenditures of $8.7 million, largely for the Electra turboprop transport, reduced net earnings of the Lockheed Aircraft Corp. from $9 million or $3.21 a share for the first half of 1955 to $7.5 million or $2.66 a share this year.

Lockheed's Missiles Systems Division, which is flying two types of research missiles for the Air Force, is near the contract stage with both the USAF and Navy, but the new business potential could not be reflected in the first-half report.

Military sales rose from $283,360,000 last year to $283,848,000 in the first half of 1956. Lockheed's military work includes operating a nuclear test center for the Air Force and nuclear airplane design and development contracts.

Lockheed backlog increased to a peacetime high of $1.3 billion. Commercial backlog of orders for 230 airliners also reached a new high of $469 million. Commercial orders received in the first half of 1956 totaled 52 airplanes from 11 airlines. However, first half sales of $51.9 million were down from the record $89.3 million established in the first half last year.

Total sales were $335 million, compared to $372 million last year. Improvement in manufacturing efficiency produced a more favorable cost-to-sales ratio, and strengthened Lockheed's earning position.

United

United Aircraft board of directors have voted stockholders the right to subscribe to shares of new convertible preference stock at ratio of one share of new preference stock for each 16 shares of common stock on record at close of business on Sept. 17 or at such later time as the registration statement covering the new stock becomes effective. Price of new shares, to be determined by board of directors shortly before subscription offer is made, will not be less than the par value of $100 per share.

Solar

Net loss of $189,200 or 27 cents a share was reported by Solar Aircraft Co., for the quarter ending July 31 as a result of a month-long strike at its Des Moines, Iowa plant. That the loss was transitory is indicated by new orders of $21 million obtained in the same quarter, bringing the company backlog to $80 million.

Solar directors declared the regular 25-cent quarterly dividend. Solar's sales for the quarter, the first of Solar's fiscal year, were $15.9 million compared with $12.9 million the year before.

When the strike began, the Des Moines plant was engaged in high volume production of jet engine and guided missile assemblies and the San Diego plant was changing over for new programs.

The result was a sharp cutback in anticipated sales and profits.

Solar net was $380,600 or 56 cents a share in the comparable three-month period in 1955.

Fairchild Camera

Fairchild Camera and Instrument Corp. earned $1.72 a share for the first half of 1956, including 42 cents from the sale of its facility at Jamaica, N. Y. Net sales of the Syosset, N. Y., firm totaled $20 million, compared with $16 million for the first half of 1955. New orders rose to $13 million.

General Controls

General Controls Co., Glendale, Calif., net was $614,193, or 69 cents a share, compared with $722,198 or 86 cents a share in the first half of 1955.

The first half 1956 sales were higher–$13.4 million compared with $12.3 million last year.

B. F. Goodrich

Sales and net income were down compared with the first half of 1955 for the B. F. Goodrich Co., Akron, Ohio.

First half 1956 sales were $364 million, net $21 million and earnings per share $2.41. Last year the comparable figures were: sales, $372 million; net $22 million, and income per share, $2.52.

Dividends

Dividends have been declared by the following companies:

- **Lockheed Aircraft Corp.**, 60-cent quarterly dividend payable Sept. 11.
- **Northrop Aircraft Inc.**, 40-cent quarterly dividend payable Aug. 31.
- **Chance Vought Aircraft, Inc.**, 40 cents, payable Sept. 24 to stockholders of record Sept. 7.
- **Glenn L. Martin**, quarterly dividend of 40 cents, payable Sept. 26 to stockholders of record Sept. 7.

Royal Australian Navy Grounds Sea Venom

Melbourne–Entire fleet of newly acquired de Havilland Sea Venom aircraft has been grounded by the Royal Australian Navy following preliminary investigations of a fatal crash. Defects in the control system are suspected, and other troubles exist which are likely to reduce Sea Venom efficiency in certain conditions.

Australian Navy's new aircraft carrier Melbourne now has all its new aircraft grounded pending further investigation. Training cruises and all flying activities have been suspended for an indefinite period of time.

Air Show Coverage

Aviation Week readers will get on-the-spot reports from three major air shows in the Sept. 10 issue.

Publisher Robert W. Martin and Editor Robert Hotz will attend the Society of British Aircraft Constructors flying display at Farnborough, England. Managing Editor Alpheus W. Jessup will cover the Canadian National Air Show in Toronto, and an editorial team headed by Military Editor Claude Witze will report on the National Aircraft Show at Oklahoma City.

Other on-the-spot international coverage by the Aviation Week staff in September will come from Rome where David Anderton, assistant managing editor (technical), is a delegate to the International Congress of Astronautics, and Edinburgh where the International Air Transport Association will hold its 12th annual general meeting.

News Digest

Royal Canadian Air Force announced increase of flying pay for air crew members from $30 a month to a graduated scale of from $75 to $150 a month. New scale, effective as of July 1, is in addition to regular pay and allowances. Purpose is to aid in recruiting, and because of "the increasing complexity of military aviation in recent years."

Boeing KC-135 jet tanker output will increase from a peak of 17 to 20 a month, following USAF recommendation that Defense Department allocate an additional $150 million for the program (AW Aug. 20, p. 29). First of

One airplane in a class all by itself

The exciting new Fairchild F-27 occupies a special place in the air world of today.

- *the only twin propjet airliner in production for local service airlines.*
- *the world's fastest executive plane – up to 280 mph cruising.*
- *flies more smoothly, with less noise, and can climb far higher than any twin-engined airplane now in airline service.*
- *the economical F-27 more than pays its way on short and long hauls . . . up to 2,250 miles.*
- *has unusually good short field operation and single-engine performance.*
- *it's the least expensive aircraft in its field at $540,000* —costs far less to buy, to operate, to maintain.*

There are no others in the F-27 class – it's one airplane in a class all by itself.

*AIRLINE: PLUG IN RADIO UNITS EXTRA.
EXECUTIVE: PLUG IN RADIO UNITS AND CABIN INTERIORS EXTRA.

FAIRCHILD
F-27 Friendship

THE FINEST AIRCRAFT FOR AIRLINES
CORPORATIONS AND MILITARY SERVICES

Address inquiries to: R. James Pfeiffer, Executive Director of Customer Relations, Fairchild Engine and Airplane Corporation, Hagerstown 15, Md.

THE NEW A-MP T-HEAD TOOL

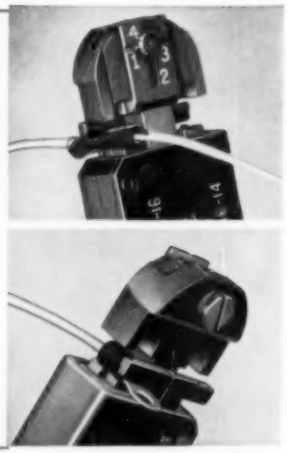
now available with

long handles and short handles

- Long handles give more leverage to delicate hands.
- Knurled plastic grips on both styles.
- Color-coded jaws and handles to match A-MP Terminals and Connectors.
- Certi-Crimp Ratchet insures perfect crimp.
- Locater stop is also wire stop.
- Provides insulation crimp on all wires, including new NAS 702 Class C.

Ask your A-MP Sales Engineer to demonstrate the New A-MP T-Head Tool.

crimps A-MP vinyl and nylon insulated terminals and connectors wire size 22 to 14



A-MP

Aircraft-Marine Products, Inc.

General Office: Harrisburg, Pa.

A-MP of Canada, Ltd., Toronto, Canada • A-MP—Holland N.V., 's-Hertogenbosch, Holland • Aircraft-Marine Products (G.B.) Ltd., London, England • Societe A-MP de France, Courbevoie, Seine, France

KC-135s will make maiden flight from Renton, Wash., to Seattle around Sept. 10 for USAF delivery. Flight may come even sooner if tests are completed.

Employment at Douglas Aircraft Co. topped 80,000 new peacetime high. Approximately 68,000 are at work in the three Southern California divisions. Total payroll for five divisions amounts to $400 million a year.

Initial steps for installation of radar at New Zealand airports were announced by Civil Aviation Ministry. Program will cost $2,064,000.

Bell Aircraft Corp. Helicopter Division announced sale of 20 Model 47G helicopters to French Air Ministry. Order is largest of year for division.

Gordon Enterprises, North Hollywood, received contract from USAF for giant camera 25 ft. long, weighing five tons, with 30-in. lens. Camera will be used by Flight Test Center at Edwards AFB.

Temco Aviation Corp. will manufacture additional McDonnell F3H Demon wings and aft fuselages. New order is carry-on of Temco's present contract providing for similar components for Navy fighter.

Republic of Indonesia ordered $5.5 million worth of UF-1 Albatross air-sea rescue amphibians from the Grumman Aircraft Engineering Corp. First delivery will be made in 16 months.

Strategic Air Command's 27th Fighter Wing at Bergstrom AFB will convert from Republic F-84s to McDonnell F-101 Voodoos in October.

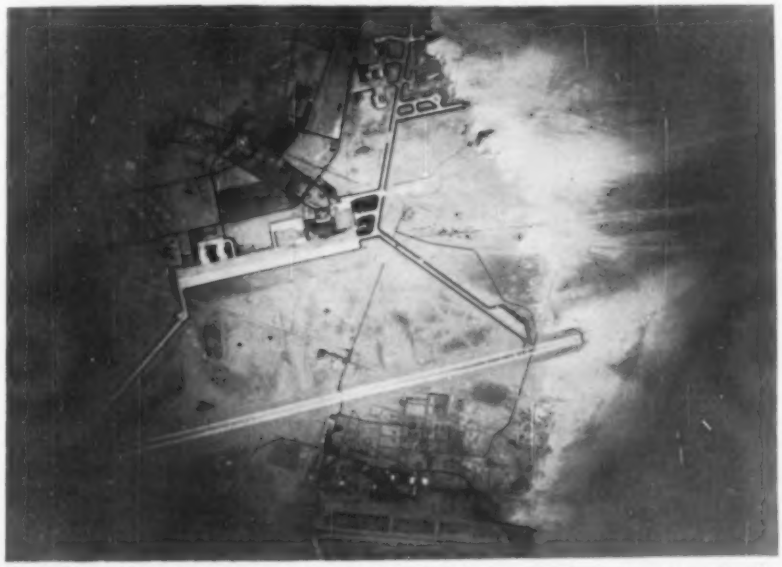
CAA Observer Tom Ray is convinced radical changes must be made in rafts and equipment for commercial aviation water rescue after witnessing Coast Guard practice ditching exercise in Biscayne Bay, Fla. Some objections: canopies and spray shields of military type raft could not be adjusted in high wind; Pan American raft lacked radar reflector; survivors could only board PanAm raft at one spot.

Lear electronic autopilots will be used in all Air France Sncase Caravelle jet transports. Contract starts with 13 advanced automatic flight control systems, the Lear 17, which uses transistors in place of vacuum tubes.

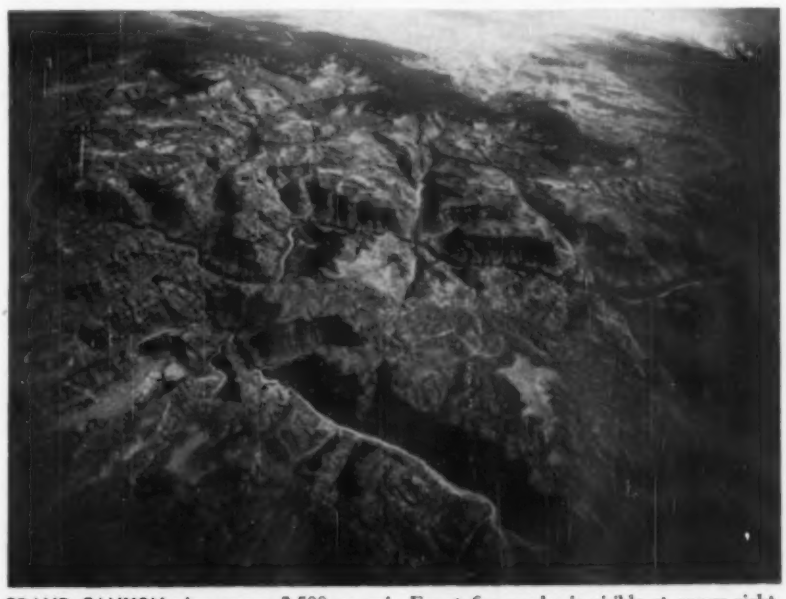
HUL-1, Bell four-place utility helicopter, participated in test trials for Navy aboard carrier Tarawa off coast of Rhode Island. Single rotor helicopter is powered by 260-hp. Lycoming VO-435 engine.

Voodoo Tests Camera Capability

McDONNELL RF-101 used forward oblique camera on California to St. Louis flight. Pictures were made at high subsonic speed, with sighting through ground glass cockpit finder.



EDWARDS AIR FORCE BASE from 30,000 ft. shows runway, road pattern sharply.



GRAND CANYON view covers 2,500 sq. mi. Forest fire smoke is visible at upper right.

Airlines Demand 'Practical' Helicopters

Air Transport Assn. challenges industry to meet promises, provide profitable commercial rotorcraft.

By Claude Witze

Washington—U.S. helicopter manufacturers are being challenged by the airlines to make good their predictions and produce at least two types of practical commercial aircraft.

In what probably is the first study of its kind that ignores even the existence of military helicopters, the Air Transport Assn.'s Committee on Rotorcraft demands two configurations for passenger service, both with multi-engine reliability:

• **For metropolitan,** or suburban operation—A 20 to 30-passenger helicopter with design payload of 4,400 to 5,300 lb. Routes will be less than 75 miles in most cases, but range of 150 nautical miles must be provided.

• **For inter-city or local service** routes—A 35-to-50 passenger helicopter with a design payload of 8,000 to 11,500 lb. Range of 300 nautical miles is essential.

Complete silence by the report on the subject of military helicopters marks the end of a long debate over the possibility that civil requirements can be merged with those of the Army, Navy and Air Force.

No Lease From Military

It also makes it clear that the airlines have abandoned all hope of leasing military helicopters from the Defense Department for operational experience.

This program, advanced more than two years ago by the Army with the support of some manufacturers, has been dropped because of opposition from top Defense Department officials.

At the same time, commercial operators have come to feel strongly that the helicopter industry, fat with government contracts, has failed entirely to work on the airline problem.

It has sold a few certificated aircraft to metropolitan operators in Los Angeles, Chicago, New York and Belgium, but all of them are adaptations of military helicopters that fail to meet real commercial standards.

There is no commercial helicopter of the capacity stipulated by the ATA committee. In addition, ATA says commercial helicopters should have such features as:

• **Fuselage width** of about 108 in. inside at window level to accommodate four-abreast seating with an aisle of 18 in.; head room of at least 80 in.

• **Cabin windows** 18 in. high and 20 to 30 in. long. Public address system and provision for a cabin attendant; at least one lavoratory, two in the inter-city helicopter.

• **Carry-on baggage** provision with 3½ cu. ft. of space for each passenger, plus overhead hat racks and cargo compartments that are easily loaded from outside.

• **Cabin doors at least 70 in. high** and 36 in. wide. Doors should be at the center of the cabin and equipped with integral steps.

Turbine H-16 Planned

No present certificated helicopter provides these comforts. Nearest approach is the Sikorsky S-58, which bears the Army designation of H-34. Outside width of its fuselage is only 68 in. In the 12-passenger commercial version, the seats are in a single line around the cabin.

Only six passengers are convenient to a window.

The Vertol H-21 is not certificated, but the manufacturer has plans to offer a commercial version powered by twin turbine engines. An Army H-21, recently modified to serve as a military executive transport, has only nine seats.

The military services have no helicopter approaching the size of ATA's inter-city aircraft, and there is almost no possibility that they ever will.

The nearest design was the Vertol H-16, a project that has been dropped by the Army. The manufacturer says plans are under way to continue development of the 40-passenger machine with turbine engines using company funds.

Industry Promises

ATA's report confines itself to what kind of hardware is needed by the airlines, what the performance must be and what kind of navigational aids and heliports will be needed. Back of this, however, lies a long history of salesmanship—and promises—by the helicopter manufacturers.

Airline representatives, particularly from the short-haul carriers, make no secret of their disappointment in the performance of the industry.

"There is no question about it," one of them told AVIATION WEEK, "that the industry oversold its product so far as we are concerned."

The spokesman cited speeches and "studies" by leading rotary-wing proponents and designers going back no farther than 1950. Some of these promised comfortable, certificated, multi-engine helicopters with seats for as many as 52 persons by 1956 or 1957. There was talk of a 40-passenger model capable of 200-mph. speeds.

"Not all manufacturers are guilty," the airline spokesman said, "but some of them are, and it has taken us quite a while to find the truth about the state of the art. Meanwhile, they are selling to the military, despite their (the military's) unhappiness about operating costs."

Actually, ATA itself had much more enthusiasm for the commercial helicopter outlook only three years ago. Basing its conclusions partially on sales talk by leading manufacturers, ATA predicted that 30-to-50 passenger helicopter buses would be competing with surface carriers by 1959 (AW Aug. 24, 1953, p. 13).

Key to the ATA forecast at that time was the fact that prototypes of the Vertol H-16 and Sikorsky S-56, both twin-engine transports, were nearing completion.

Seat-Mile Costs

At the time, their appearance was blamed for part of the coolness shown by short-haul operators towards a fixed-wing replacement for the DC-3.

Another study, published near the end of 1953, predicted that a third of all inter-city passengers would fly in helicopters by 1970. It was forecast that there would be six million of them a year by 1960.

The present ATA report declares that a helicopter operated by an airline must attract the low-fare, short-haul market and for this reason must have the lowest possible costs per seat or ton-mile.

For the smaller, metropolitan service aircraft, this is understood to mean a figure near 10 cents a seat-mile. In the case of the larger, inter-city helicopter the cost should go down to five or six cents a seat-mile. No present helicopter shows any promise of meeting these figures.

Seat-mile costs for commercial operators are now nearer 50 cents.

Pointing out that the designer should bear in mind that the transport rotorcraft is virtually a "flying bus," the ATA

report says cabin appointment must be simple and easily maintained. Passengers must be able to embark and disembark easily from its cabin.

The report also emphasizes safety and declares that systems and components must be designed so that, if they fail, they "fail-safe."

The ATA committee declared that all-weather reliability is vital for commercial operations and that navigational and landing aids must be developed to make this possible.

Heliport Study

On the subject of heliports, the study calls for action based on what is known about helicopter operation.

It sets up criteria as to size, location, zoning, safety, noise problems, obstructions and facilities.

The report admits that some of these standards may have to be changed on the basis of operating experience, but the report says that, unless steps are taken now to provide heliports, undue restrictions lie ahead.

On this subject, ATA and the International Air Transport Assn. disagreed with the manufacturing industry nearly two years ago when the latter discouraged cities and towns from planning heliports.

The Aircraft Industries Assn. Helicopter Council urged at the time that no plans be formalized until more was known about the operating characteristics of commercial helicopters (AW Nov. 29, 1954, p. 13).

No Mention of STOL

The report makes no mention of STOL and VTOL aircraft as a possible replacement for the helicopter despite current military enthusiasm for this type of aircraft.

(One of the reasons given by an Army spokesman for abandonment of the H-16 development project is that the money is needed to press work on other more promising experiments in the STOL field.)

Operating experts from short-haul airlines do not deny that the STOL idea holds promise. But, in pressing for more realistic action by helicopter manufacturers to meet their needs, they feel that it will be 1965 or 1970 before STOL or VTOL becomes a commercial possibility.

Earlier Arrival

In recent years, the helicopter manufacturers have pledged that practical airline helicopters will be in operation nearly a decade before STOL aircraft can be available.

Airline operators seem to feel that, if the helicopter manufacturers turn to the newer types of transport, the airlines may again be left waiting while military demands are fulfilled.

RUSSIANS are also letting their enthusiasm for commercial helicopter operations outstrip performance. Above is a Russian artist's conception of a commercial helicopter operation linking Vnukovo Airport with downtown Moscow. Sketch shows a civil version of Mil-4 helicopter using Dzherijinsky Square on the edge of the Kremlin as a downtown heliport. Moscow Hotel is large building in background.

Airline Pilots Cut From Ready Reserve

Washington—The Air Force has ordered airline flight personnel in the USAF Reserve removed from units that are on a mobilization basis. The Air Force action, which affects 300 reservists, means that flight crews and other key airline personnel can no longer hold positions in the Air Force Reserve.

The Navy has declined to follow the Air Force lead and will continue to use employes of the air transport industry in its active reserve programs.

Under the new policy, airline pilots, navigators, radio operators, flight engineers, key support personnel and key managerial personnel cannot fill Air National Guard or Air Force Ready Reserve mobilization positions. They are to be reassigned to a reserve program which does not require immediate availability in a national emergency.

In an emergency situation, the airlines will be flying military transport missions as part of the Civil Reserve Air Fleet and will provide domestic transportation under the War Air Service Pattern. Aircrews and other key airline personnel will be needed for these mobilization activities and won't be available for active duty as reservists.

In order to be sure that all ready-reserve units are composed of personnel available for emergency active duty, the Air Force will transfer airline employes to other programs.

The new policy does not affect the reserve status of the reservists involved. They can continue to earn points for retirement, and officers can maintain their eligibility for promotion. Reservists removed from paid mobilization positions can train by correspondence courses or be assigned to an Air Force Reserve Center unit for general training without mobilization assignment.

Air National Guard pilots who were trained under Air Training Command quotas will serve out the tour of duty to which they are committed and will be ordered to active duty in an emergency. Reservists considered essential to the operational training function of Continental Air Command and Air National Guard units will be retained until adequately replaced.

Transatlantic Summer Air Traffic Falls Short of Expectations

By Glenn Garrison

New York—North Atlantic scheduled summer traffic, although up about 12% so far over 1955, is falling considerably short of the 20% or greater increase expected by the airlines at the beginning of the year. Scheduled lines carried about 251,000 passengers during May through July, according to industry sources. Last year's total for the comparable summer period was about 224,000.

Overall load factors on the transatlantic carriers have been somewhat disappointing this year, too. During none of the three months was an average load factor of 90% reached eastbound or westbound. Eastbound, the highest figure was reached in June, with an 89% load factor; the westbound figure for that month was less than 50%.

Passenger Totals

Approximate eastbound passenger totals for the three months were May, 36,000; June, 62,000; July, 51,000. Westbound, the totals were 27,000 for May, 32,000 for June, and 43,000 for July.

On the basis of three months' figures, capacity appears to have outrun the business to some extent. There were some 381,000 seats available in both directions during the period, compared to 309,878 seats during the same period of 1955. Capacity increased about 22% eastbound and about 24% westbound, whereas the traffic increase was 10% eastbound and 15% westbound during the three months.

First-class traffic lag has done most to brake the transatlantic traffic rise. The 33,000 first-class passengers who flew the Atlantic eastbound during May through July represented virtually no increase over 1955. At the same time, eastbound first-class seats were up 12% to 45,000. Westbound, first-class passengers were up 8% to 27,000, first-class seats up 10% to 44,000.

Tourist traffic fared better: 116,000 eastbound passengers were recorded, a 13% increase. Westbound, the tourist total was 75,000, a rise of 18% over last year.

Tourist seating capacity was up 25% eastbound and 29% westbound during the period.

August Improvement

However, the season isn't over yet, and August figures will show a boost over July's. But first-class traffic may continue to be significantly off.

Trans World Airlines reports a July loss of about 10% from July 1955 in transatlantic first-class traffic, along with an approximate 7% rise in tourist passengers. For August, TWA expects the first-class total to be some 16% less than last year. The airline's tourist traffic for August is expected to be about 18% greater than for the same month in 1955.

Pan American World Airways experienced an 8% first-class traffic increase in July over last year, with a 12% boost in tourist totals. For August, Pan American expects a 6% gain in first-class, a 24% gain in tourist traffic.

PAA Signs Aeroflot Pact

Pan American World Airways became the first American airline to have an exchange agreement with Aeroflot with the signing of an interline pact in Moscow.

Signing of the agreement, which calls for exchange of passengers and cargo between the two carriers, is viewed as a possible step towards the introduction of direct service to Moscow by Pan American.

The U. S. flag airline opened negotiations with the Russian airline at the suggestion of the Soviet government and with the approval of the State Department. Negotiations conducted in Moscow led to the signing of a Pan American-Aeroflot interline pact.

CAA Lists Airways Construction Program

Washington—A partial list of airports to receive more airways and navigation facilities in addition to the 16 areas earmarked for long-range radar (AW Aug. 27, p. 40) has been announced by the Civil Aeronautics Administration.

New facilities being commissioned during Fiscal 1957 will represent the first major step towards implementation of the three-year federal airways plan.

The program calls for control towers in 17 locations, high-intensity approach lighting in 19 areas and VOR equipment at 82 airports. Airports to receive air traffic control towers are:

Westfield, Mass.; Salem, Ore.; Erie, Pa.; Utica, N. Y.; Columbus, Ga.; Longview, Texas; Fargo, N. D.; St. Joseph, Mo.; Santa Fe, N. M.; Fayetteville, N. C.; Stockton, Calif.; Lynchburg, Va.; Worcester, Mass.; Lafayette, La.; Macon, Ga.; Rockford, Ill. and Hobbs, N. M.

Approach Lights

High-intensity approach lights will be installed at:

Albany, N. Y.; Charleston, W. Va.; Dayton, Ohio; Newark, N. J.; Austin, Texas; Greensboro, N. C.; Indianapolis, Ind.; Ft. Wayne, Ind.; Billings, Mont.; Louisville, Ky.; Atlanta, Ga.; Birmingham, Ala.; Dallas, Texas; Houston, Texas; Nashville, Tenn.; St. Louis, Mo.; Burbank, Calif., and Spokane, Wash.

New VOR

VOR equipment will established at:

Agricola, Ga.; Akron, Ohio; Altoona, Pa.; Astoria, Oregon; Austin, Nevada; Basolt, Nevada; Beatrice, Nebraska; Bishopville, Md.; Blackwells Corner, Calif.; Burlington, Vt.; Canton, Ohio; Carrollton, Mo.; Cavutaville, N. Y.; Charlestown, W. Va.; Cincinnati, Ohio; Clarksburg, W. Va.; Cody, Wyo.; Coles Point, Va.; Keene, N. H.; Knobnoster, Mo.; Lakeview, Oregon; Lancaster, Pa.; Liberty, N. Y.; Manchester, N. H.; McCall, Idaho; McCracken, Pa.; Milford, Del.; Miami, Fla.; Molokai, T. H.; Mooresville, Mo.; Newcomerstown, Ohio; Newhall, Calif.; New Madison, Ohio; Northfield, Vermont; O'Neill, Neb.; Oshkosh, Wisc.; Coxcomb, Calif.; Crandall, Texas; Decatur, Ill.; Del Rio, Texas; Detroit City, Mich.; Edenville, N. Y.; El Centro, Calif.; Elk Creek, Wash.; Elgin, Wash.; Ethel, Wash.; Evanston, Illinois; Farallon Islands, Calif.; Fern Prairie, Wash.; Flint, Mich.; Fowlerville, N. Y.; Gilroy, Calif.; Gulfport, Miss.; Hickory Grove, Pa.; Hog Island, Va.; Huntington, W. Va.; Hyannis, Mass.; Jamestown, N. Y.; Jefferson, Missouri; Princeton-Bluefield, W. Va.; Polvardero, N. M.; Rainelle, W. Va.; Richland Center, Ind.; Richmond, Ind.; Rock Springs, Ariz.; San Bernardino, Calif.; Sandusky, Ohio; Shelbyville, Ind.; Shipman, Illinois; Show Low, Ariz.; Sidney, N. Y.; Sparta Junction, N. J.; Sweetvalley, Pa.; Springville, Pa.; Vesta, Va.; Walhalla, S. C.; Warm Springs, Nev.; Waterville, N. C.; Wellsville, N. Y.; Westfield, Mass.; Williamsport, Pa. and Zanesville, Ohio.

Swissair's First Half Cargo Business Increases

Swissair's cargo operation for the first six months of 1956 totaled 3,349,918 ton-miles, an increase of 43% over last year, the airline has reported. Biggest gain—66%—occurred on the North Atlantic route. Swissair cargo business was up 25% in Europe, 7% in the Near East, 42% in South America.

The airline plans a second weekly transatlantic all-cargo flight in October.

Tacan/DME Chosen for U.S. Airways

By L. L. Doty

Washington—Tacan compatible DME will be adopted as the common U.S. air navigation system.

The Tacan controversy, waged between military and civil aviation factions for more than seven years, came to a compromise settlement late last week when the Air Coordinating Committee accepted its Navigation Panel's recommendations.

The Air Coordinating Committee's final decision includes the installation of Tacan stations to replace DME units. Under this arrangement, civil aircraft will be equipped with stripped-down Tacan receivers for distance information. VOR and ILS would remain in use for azimuth data and instrument approach. Military aircraft would be fully equipped with Tacan receivers for all navigational requirements.

The compromise decision is the only practical solution if co-existence of the two systems is to be made technically possible since both Tacan and DME operate in the 1,000 mc band. Tacan has been favored by the military because it offers better security coverage in tactical operations while the Civil Aeronautics Administration has supported DME/VOR as more efficient and accurate.

NBAA Opposition

Even before the decision was formally announced National Business Aircraft Association protested to Louis Rothschild, Undersecretary of Commerce and ACC chairman, that the decision meant "the crucifixion of civil aviation's common system." The Airline Pilots and Owners Association indicated that it also would vigorously oppose the ACC action. The Air Transport Association, an early opponent to Tacan, took a neutral stand in the final stages of the debate, declaring that a final decision "has been, and still remains, the essential element of the airline position in this matter."

The Tacan issue has been the cause of much bitterness in aviation circles and a primary reason behind the long delay in the development of a modern airways system. At one time, the battle led to mass resignations in the Navigation Committee of the Research and Development Board.

It has been the target of a number of congressional hearings and, at one time, almost spelled an end to the Air Navigation Development Board.

Navy Instituted Tacan

The Navy began the development of Tacan during the 1948-49 period in a search for a combination rho-theta system capable of providing accurate bearing and distance measuring information for carrier operations, requirements VOR/DME could not fill.

The Air Force joined the Navy in supporting Tacan because the need of a security-bound continental defense system became evident with the explosion of the first atomic bomb by the Russians.

The struggle was long aggravated by the security clamps put on Tacan's development. As a result, the Civil Aeronautics Administration continued its development and implementation of DME/VOR without official knowledge of the Tacan program progress until 1953. By this time CAA had invested $20 million in 450 DME stations.

The veil of secrecy on Tacan was officially lifted in late 1954 when the Navy disclosed some of the details of the system during a Radio Technical Commission for Aeronautics symposium in Washington. AVIATION WEEK had first revealed the Tacan/DME controversy Dec. 7, 1953.

After final declassification of Tacan last year, the controversy continued to flare up as varying solutions to the dilemma were suggested. As late as March 1955, the ANDB cleared the way for the adoption of Tacan as the common system with VOR to serve until 1965 as an interim system. DME service was not to be guaranteed beyond June, 1955.

The CAA refused to bow to the military, however, and continued with its VOR/DME program. ATA, NBAA and AOPA lined up with CAA to bring the struggle to a head this year. During a hearing before the House Government Operations Subcommittee, Rothschild disclosed that the ACC would reach a final decision on the long-debated controversy late this summer.

Meanwhile, the Air Transport Assn. withdrew from its original stand and asked only for a final settlement to the problem to clear the way for a single federal airways system.

Ozark Hi-Per DC-3

Conversion of former Swissair DC-3 for Ozark Airlines includes Hi-Per modifications such as wheel well covers, revised exhaust, in-a-door stair, but uses Pratt & Whitney R-1830-82 engines instead of usual R-2000s. Conversion was done at Pan American Airways Hi-Per modification facility at Brownsville, Tex.

North American Plans Jet Utility Transport

Los Angeles—North American Aviation, Inc., last week announced its decision to enter the race for the large Air Force market in twin-jet utility planes by manufacturing a sweptwing four-passenger-trainer-transport.

North American said it already has completed wind tunnel tests and 25% of the estimated engineering for a transport and combat trainer that will cruise at 45,000-ft. and fly more than half way across the continent without refueling. The aircraft, powered by General Electric J85 turbojet engines, will have a takeoff gross weight of approximately 14,000 lb. Length will be 43 ft. and wingspan 42 ft.

It will carry a crew of two and four passengers. North American said engineering work began early this year after exhaustive preliminary studies. A mock-up will be completed by October and first flight will be early in 1958.

Air Force's Air Materiel Command recently asked 28 manufacturers to consider developing between 1,200 and 1,800 small and medium jet planes for joint commercial-military sales (AW Aug. 27, p. 29).

Cost of prototype development and flight testing of the North American utility plane is estimated at approximately $5 million.

Advantages of the

ROLLS-ROYCE

CONWAY

BY-PASS TURBO JET

for long range airliners

★

Lower weight giving increased payload

Lower guaranteed specific fuel consumption

Lower first cost and operating costs

Less noise

★

ROLLS-ROYCE AERO ENGINES LEAD THE WORLD

ICAO Pacific Pattern Revised To Permit 'Random' Flight Paths

Washington—A system of "random" flying over the Pacific Ocean that will give pilots a free choice of transocean air tracks has replaced the historic fixed route pattern.

Under a new International Civil Aviation Organization ruling that became effective on Sept. 1, pilots may now plot unrestricted transpacific courses that will enable them to take full advantage of favorable winds and weather conditions.

The system is similar to that governing transatlantic flights.

Previously, transpacific pilots were required to follow one of six established routes between Honolulu and the West Coast. Controlled airways to Wake and Guam were pre-designated tracks 50 mi. wide with a minimum altitude of 2,500 ft. Tracks westward to the Far East were similarly established to conform with routes most commonly flown.

Pilots may now file flight plans over routes of their own choosing without conforming to a pre-established pattern. Courses may be changed en route or flight plans revised only at designated fix points and only after receiving permission from control centers.

All tracks are now set at a width of 140 mi. to allow a 50-mi. leeway and a 20-mi. buffer zone on either side of a central course. A vertical separation of 1,000 ft. is required, and aircraft must hold to a 20 min. longitudinal separation. (The North Atlantic tracks are 120 mi., 1,000 ft. and 30 minutes.)

Navy is insisting upon a minimum altitude of 5,000 ft. for transport aircraft to prevent interference with carrier activity, although it has agreed to give consideration to lower altitude limits in certain areas. Airlines seek lower altitude minimum as one method of avoiding headwinds.

Chief advantage of the random system to the airlines lies in the freedom to select routes that offer the greatest assist from winds and which permit circumventing of poor weather areas.

The old system, based primarily on DC-4 requirements, was created in 1948 by the ICAO Northern Pacific Regional Air Navigation Committee at a meeting in Seattle when high-altitude flight was not a factor in overseas operations.

However, with the introduction of faster airplanes and pressurized cabins, the airlines felt that an unnecessary operational penalty was imposed by the fixed-route principle. Primarily, the airlines were anxious to take full advantage of the jet stream and other wind currents to maintain maximum operational and economic efficiency.

Furthermore, the airlines decided that jet transport operations will require greater flexibility in traffic flow than would be possible under the old route system. As a result, control of all air space to permit random flying was adopted at a regional air navigation meeting in Manila during November 1955.

All flights will continue to operate under the jurisdiction of Air Route Traffic Control Centers. Centers operated by the Civil Aeronautics Administration are located at Oakland, Seattle, Anchorage, Honolulu and Wake Island.

Centers operated by the military are located at Guam, Midway, Kwajalein, Okinawa and Tokyo.

CAB Postpones Action On Bermuda Fare Hike

Washington—Civil Aeronautics Board has deferred action on international airline agreements involving emigrant fare discounts and Washington-Bermuda fares. Both probably will be eventually disapproved.

The emigrant fare plan was proposed at the Cannes meeting of the International Air Transport Assn. The plan would offer a 40% discount from tourist fares to emigrants from Europe.

Pointing out that it had disapproved similar plans in the past, the CAB said it would defer action on the new proposal with a view towards eventual disapproval.

The Board said it appreciates the desirability of facilitating emigrant traffic but feels that "this aim may be more adequately accomplished through the use of charter services, or other means, which do not involve the discriminatory features here presented."

The IATA agreement involving Washington-Bermuda fares would raise Eastern Air Lines' tourist and first-class fares on the route it absorbed when Eastern took over Colonial Airlines June 1.

Eastern's Colonial Airlines Division flies between Washington and Bermuda via New York. The current fare between Washington and Bermuda is the same as the New York-Bermuda fare. Under the IATA plan, the Washington-Bermuda fare would be increased by the amount of the regular Washington-New York fare.

The CAB said it would not mind a fare increase that reflected the mileage difference on the two routes (Washington is 54 mi. further from Bermuda than is New York). But the Board found the proposed fare exceeds this purpose and would have an impact on domestic fares to the south and west of Washington.

Northwest Awarded New Pittsburgh Routes

Washington—Civil Aeronautics Board has awarded Northwest Airlines authority to operate local service between Pittsburgh-Cleveland and Pittsburgh-Detroit.

With its new authority, the airline can fly a competitive turnaround service in the Pittsburgh-Cleveland and Pittsburgh-Detroit markets now dominated by Capital Airlines.

The CAB also completed an unfinished part of the New York-Chicago case, decided last September, with a decision to allow Eastern Air Lines to continue to operate between Pittsburgh and Akron/Canton, Cleveland and Detroit with a long-haul restriction.

In the New York-Chicago Case, the Board temporarily lifted a closed-door restriction that prohibited Eastern from carrying passengers between Pittsburgh and Akron/Canton, Cleveland or Detroit. Final decision on the restriction issue was deferred for consideration with Northwest's application for turnaround authority.

Northwest was chosen over Eastern to offer new competition for Capital on the route because Northwest is the smaller of the two airlines. The Board said the primary reason for choosing Northwest was that "between Northwest and Eastern, Northwest is much the weaker carrier and is in need of strengthening."

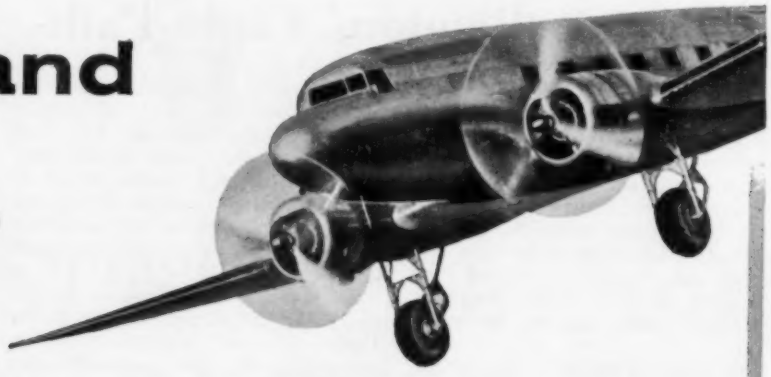
Mohawk Expects Profit From Mail Rate Change

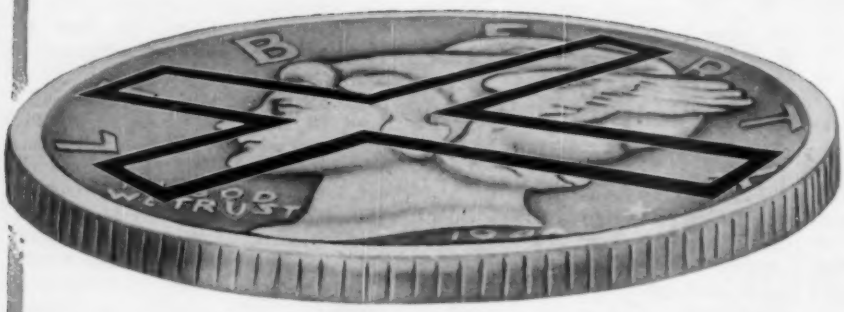
Mohawk Airlines expects its 1955 loss of $65,956 to change into a net profit after renegotiation of a temporary mail rate under which Mohawk operated during the last six months of the year. The local service carrier, in its annual report, also predicts a subsidy-free operation by the early 1960s.

Mohawk flew 283,000 passengers a total of 51 million passenger-miles during 1955, the airline reports, for a traffic growth of 28%. Mohawk ranked fourth in passenger traffic among U.S. local service carriers.

Describing the integration of Convair 240s into its DC-3 fleet, Mohawk reports the Convairs were superior in productivity, earning capacity and attractiveness to passengers. Maintenance delays were five to one over the DC-3s during initial operation, Mohawk reports, but the ratio leveled out as the maintenance learning curve progressed.

ever land on a dime?





SC-24 for multi-engine airplanes

SC-12 for single-engine airplanes

Corporate pilot, sportsman, or business executive—you have had the experience of landing on a short strip, and the same uncertainty in a take-off from a short runway . . . and there are *many* of them throughout the country!

Safe Flight's SPEED CONTROL SYSTEM automatically handles the variances in take-offs, climbs, approaches, landings, and all slow speed maneuvers. It eliminates making airspeed approximations for weight, power, flaps, acceleration, ground effect, density altitude, etc.

By centering the pointer of the Panel Mounted Indicator, you know you are maintaining the *ideal* approach speed, eliminating runway overshoots or undershoots. For take-offs, you are assured of maximum obstacle clearance, best initial climb under all weight and power conditions, and optimum speed in the event of engine failure on multi-engine airplanes.

Stocked at major distributors or write to:

SAFE FLIGHT INSTRUMENT CORP.
White Plains, New York

"PIONEERS IN LIFT INSTRUMENTATION"

Polish Airline Details Post-War Growth

Warsaw—After ten years of scheduled operation, Polskie Linie Lotnicze (LOT), Communist Poland's state airline, reports that it has increased its passenger traffic four-fold over the pre-World War II level. It hopes to triple present traffic volume within the next five years.

Last year, the airline carried 154,822 passengers on its domestic and international routes, according to International Air Transport Assn. reports. The carrier itself claims an annual load factor of over 79%.

Comparing present traffic with prewar Polish airline operations, LOT claims that, using the 1938 traffic level as a base of 100, ton-kilometers have reached an index of 550 for all services and 1,905 for domestic operations. Passenger traffic is set at 392 overall and 1,760 domestically.

The Polish Government established LOT after World War II with the help of the Russian air force. War damaged installations were repaired, and the airline began scheduled service in 1946.

The carrier's schedules are tied into the transportation network so that flight arrivals and departures are timed to match railroad and bus schedules.

Flight frequencies reach a high of five to six trips a day on some Polish route segments, and air-taxi service supplements regular airline schedules.

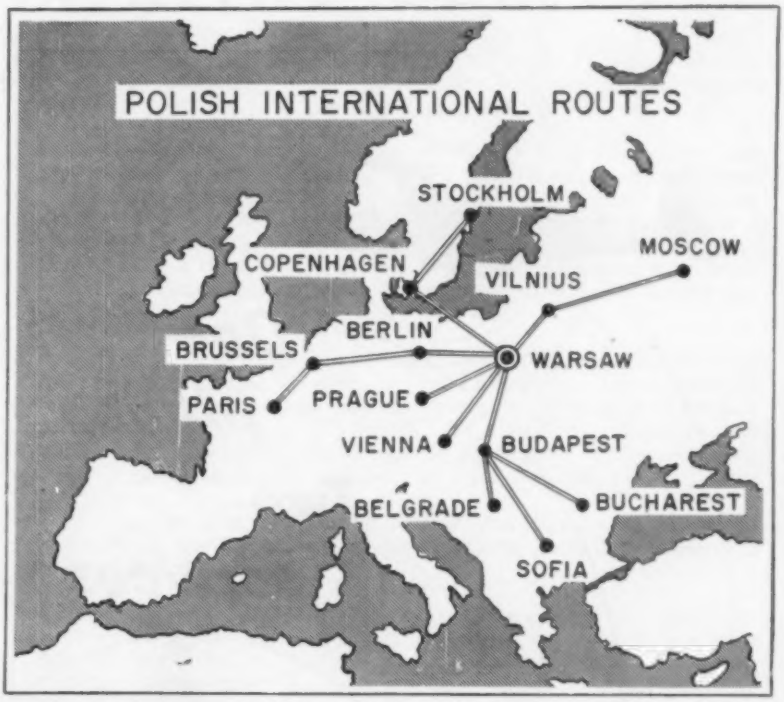
At present, the Polish airline is flying over its route system with a mixed fleet of Li-2, Il-12, Il-14 and C-47 equipment. The carrier also operates dozens of light aircraft.

LOT's domestic route structure is designed to connect Warsaw with the nine provincial centers—Krakow, Wroclaw, Lodz, Poznan, Bydgoszcz, Stettin, Stalinogrud, Gdansk and Rzeszow. The carrier's system also connects the provincial centers and links the southern industrial regions with the northern seaports.

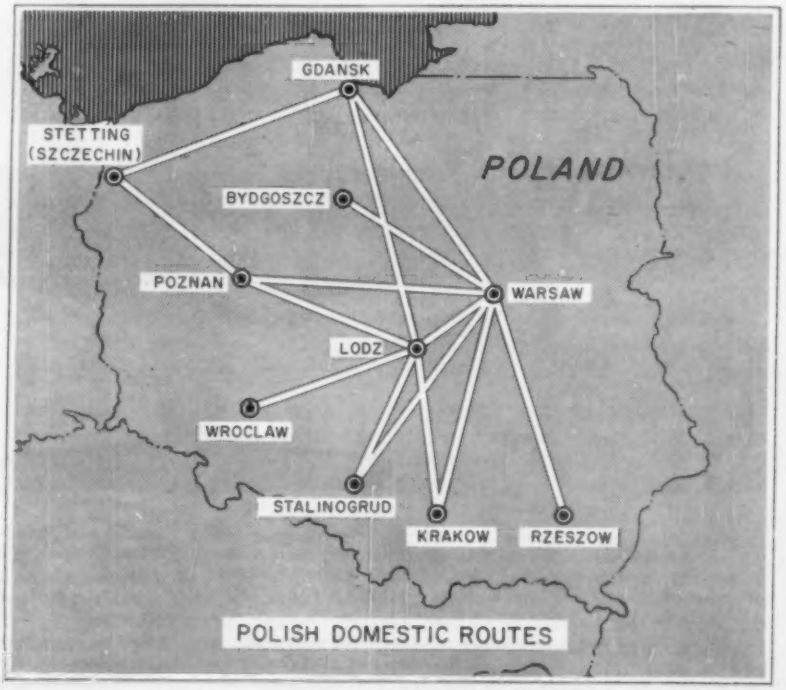
Connections are made at Warsaw with international routes. LOT also flies to Paris, Brussels, Stockholm, Berlin, Copenhagen and Vienna in Western Europe; to Moscow and to Belgrade, Sofia, Prague, Budapest and Bucharest in Eastern Europe.

Warsaw's Okecie Airport serves as a junction point for operations of such foreign carriers as KLM Royal Dutch Airlines, Aeroflot, German Deutsche Lufthansa, Czechoslovakian Airlines, MALEV Hungarian airlines, GVF Bulgarian airlines and TAROM Rumanian airlines.

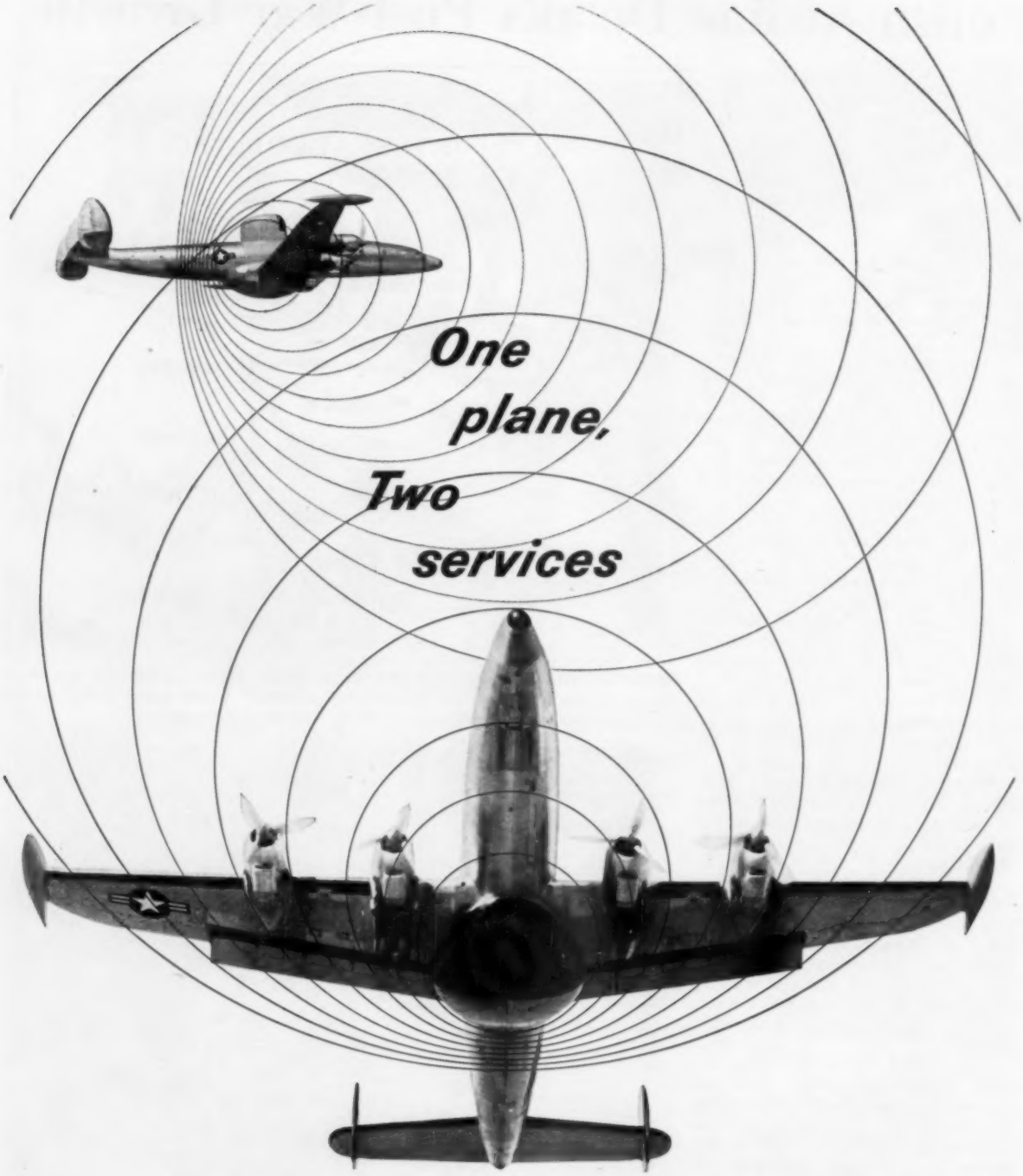
Along with its transport operations, LOT operates a fleet of light planes for agricultural, forestry and aerial mapping work.



INTERNATIONAL routes of LOT link Warsaw with European capitals—East and West. Foreign carriers also operate into Warsaw's Okecie Airport. Besides dozens of light aircraft, the airline operates a mixed fleet of Li-2, Il-12, Il-14 and C-47 equipment.



DOMESTIC route structure of Communist Poland's state airline, LOT, connects Warsaw with nine provincial centers, and links southern industrial regions with northern seaports. Flight frequencies reach a high of five to six trips a day on some Polish route segments, and schedules are tied into the national transportation network so that flight arrivals and departures are timed to match railroad and bus schedules.



In this perilous age when even *one* thermonuclear weapon can devastate a vast area, the vital role of maintaining our nation's first line of aerial defense has been entrusted to the Lockheed-designed-and-built radar picket plane – the U.S. Air Force's RC-121D and the U.S. Navy's WV-2.

In darkness and fog, in fair weather and foul, these twin sentinels operate around the calendar and the clock, at altitudes up to 25,000 feet and at speeds up to 300 mph. Pressurized and air-conditioned, they provide 75-degree cabin comfort for a 31-man crew, even when outside temperatures are 60 below zero.

The antenna reflector assembly in the belly radome of these picket planes was developed by Lockheed—enabling them to radar-scan an area of 45,000 nautical square miles from 10,000 ft. altitude.

Only Lockheed produces long-range, AEW planes—a tribute to the all-weather capabilities of the RC-121D/WV-2, and to Lockheed's leadership in the early-warning electronics systems field.

Lockheed

AIRCRAFT CORPORATION, BURBANK, CALIFORNIA *Look to Lockheed for Leadership*

Shortlines

▶ **British Overseas Airways Corp.** operated its New York-Bermuda service with a passenger load factor of 97% in May, June and July. BOAC operates two first-class flights a week and a daily tourist service over the route, all with Viscount equipment.

▶ **European airlines** will increase flight frequencies by 7% and seat capacity by 12% under new schedules which become effective in October. Capacity will be increased with the introduction of Britannia, DC-7C, Metropolitan, Viscount Major and S-58 equipment this winter.

▶ **International Air Transport Assn.** reports that 9,350,000 passengers traveled over the international routes of the 73 IATA airlines last year. International passenger traffic increased 19% in 1955. While international passengers comprised 18% of the total on all services of IATA airlines, they accounted for 29% of the passenger-miles flown in scheduled service in 1955.

▶ **Riddle Airlines** has selected Atlanta as a division base for its midwest route. The base will handle eight scheduled flights a day, including a non-stop Atlanta-Chicago service established this month.

▶ **Swissair** has three two-week tours of European cities ready for introduction of the IATA excursion fare on Oct. 1. The all-expense tours include trips to London, Amsterdam, The Hague, Brussels and Paris for $586; to Geneva, Madrid, Paris and London for $633; and to Rome, Nice and the French Riviera, Paris and Versailles, London and Windsor for $682.

▶ **Trans American Airlines** reports a 13.4% increase in gross revenue for the first half of 1956. Revenues for the first six months were $7,604,410, and the airline flew 120,369 passengers 180,086,000 passenger-miles.

▶ **Trans World Airlines** will now give ticket stock to firms that are frequent TWA customers. A company travel desk checks reservations by phone, makes out the ticket, and the company reports monthly on the transportation used. . . . TWA has joined a new freight bill clearing plan of the Chase Manhattan Bank.

▶ **United Air Lines** will shift its family plan schedule Oct. 1 so it will be effective from Monday noon to Thursday noon instead of the present Tuesday to Thursday schedule.

AIRLINE OBSERVER

▶ CAA has raised its employment requirements for traffic controllers from 50 to 300 recruits per month to man the expanded airways facilities scheduled under the three-year federal airways plan.

▶ **Air Line Agents Assn., an affiliate of the Air Line Pilots Assn. and representative of some 1,300 office workers and station agents of National Airlines, is suing the company for damages and retroactive pay. The union claims that failure to issue two weeks notice on lay-offs because of a threatened pilots strike was a violation of current contract. Pilots had set August 17 as a strike date, and the airline slowed operations to a virtual standstill in preparation for the strike which the pilots failed to carry out (AW Aug. 27, p. 45).**

▶ Aeroflot is flight testing the Tu-104 for scheduled service by replacing Il-12 and Il-14 equipment with the jet transports on certain specified trips. Tu-104 passenger flights have been conducted recently from Moscow to Copenhagen, Bucharest and Peking. For some time, the airplane has operated extensive non-scheduled proving runs over the Moscow Orient Express route to Khabarovsk in Siberia (AW July 9, p. 26).

▶ **Air Transport Assn. has received permission to intervene in the general passenger fare investigation by the Civil Aeronautics Board despite objections of the CAB Bureau Counsel.**

▶ Bristol Aircraft urged British Overseas Airways Corp. to operate its Britannia 100s over the North Atlantic route into New York to help boost sales of the turboprop transport. BOAC, however, will schedule the Britannia over Empire routes when the new aircraft goes into service in October. With the Britannia and the Comet IV, BOAC hopes to recover lost ground on its Eastern and African routes from which approximately 65% of the airline's traffic is derived. Boeing Stratocruisers will be kept on the transatlantic route until BOAC receives the longer-range Britannia 300s sometime next year.

▶ **Trans-Canada Airlines will begin a pay-later travel plan on Oct. 1 after long resistance to the down-payment system. The credit plan will be available for flights on all TCA routes in North America and Europe.**

▶ Four female co-pilots are being recruited by a West Coast supplemental carrier because of the acute shortage of transport pilots. The carrier needs pilots qualified to fly DC-3 and DC-4 equipment to fill crew complements but will require the women to double as stewardesses. While this is the first such request that the Pilots Employment Agency has received, calls previously have been accepted for women pilots to fly executive aircraft.

▶ **Chicago Helicopter Airways is the new name of Helicopter Air Service, the airline certificated to operate a scheduled helicopter passenger service in the Chicago area.**

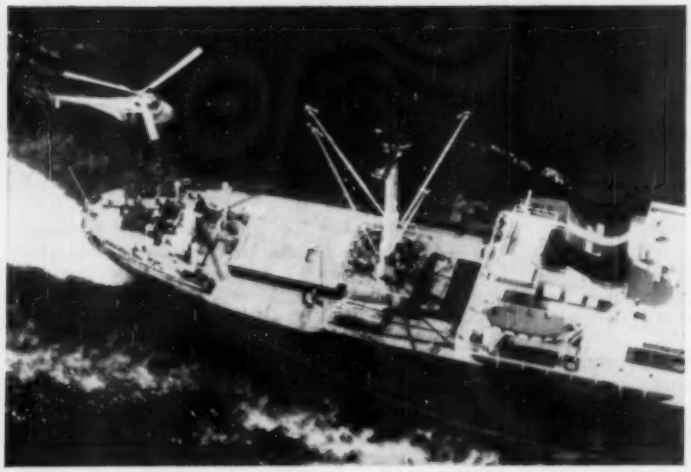
▶ Government-owned Trans-Australian Airlines and Australian National Airways have sliced tourist-class fares in a rate war being waged against the low-fare, privately-owned Ansett Airways, which operates Convair 340 aircraft, and Butler Air Transport operating Vickers Viscounts. Ansett will shortly introduce Convair Metropolitan 440s into service.

▶ **Northwest Airlines will redesign the interior of their aircraft next year when delivery of 14 DC-7Cs and eight DC-6Bs is accepted. New interiors, suggested by Douglas Aircraft designers, will emphasize newly-styled carpeting, seat fabrics and curtains. Walnut coloring in varying shades will prevail on walls and bulkheads. Exterior design will undergo only slight modification**

▶ Beirut Airport has opened a tax-free market with 24 separate stores to accommodate over 250,000 transient passengers annually.

IN THE MEDITERRANEAN SEA—Participating in amphibious exercises of the U. S. Navy in the Mediterranean area are Sikorsky HRS helicopters of the Marine Corps. They are shown above with the escort carrier *Siboney*, which carried 15 helicopters from their home base at New River, North Carolina. The training exercises featured helicopter vertical envelopment tactics.

AROUND THE WORLD WITH SIKORSKY HELICOPTERS



SAVED—A DANISH SEAMAN—A Sikorsky HO4S helicopter from the U. S. Coast Guard Station at Salem, Mass., takes a Danish sailor from the merchant ship *Paula Dan* 25 miles off Block Island. The sailor, stricken with acute appendicitis, was lifted in the basket visible below the helicopter and was flown to a hospital ashore for surgery.

SAVED—A U. S. COASTGUARDSMAN—Two days later the same HO4S helicopter picked up a U. S. Coastguardsman from the Nantucket Lightship. Also a victim of acute appendicitis, the man was quickly and safely taken to the same shore hospital. Helicopters have rescued more than 10,000 people in all parts of the world.

LARGER S-58s FOR NEW YORK AIRWAYS—The first of a new fleet of 12-passenger Sikorsky S-58s has been delivered to New York Airways, the helicopter airline serving Greater New York and nearby communities in three states. Sabena Belgian World Airlines has ordered eight for its European helicopter service. Both lines currently use Sikorsky S-55s. The S-58s will be the largest helicopters to be in regular airline service anywhere in the world.

HELICOPTER HISTORY

FIRST SCHEDULED HELICOPTER SERVICE

On October 1, 1947, the world's first scheduled helicopter service was started by Los Angeles Airways, carrying air mail. One of the line's original Sikorsky S-51s, above, is still operating and has flown 10,000 hours. Los Angeles Airways was a pioneer in night operation and instrument flying, and carried over 10 million pounds of air mail in its first three years. The line now carries passengers as well as mail and express in its fleet of Sikorsky S-55s.

SIKORSKY AIRCRAFT
BRIDGEPORT, CONNECTICUT
One of the Divisions of United Aircraft Corporation

Scientists Tackle Jet Noise Problem

By George L. Christian

Cambridge, Mass.—There are three basic ways to calm the noise poured forth by a large jet engine: use a quieter engine, install a muffler, or persuade the public to accept the noise, according to the acoustical consulting firm of Bolt Beranek & Newman, Inc., who are devoting considerable time and energy to the matter. The imminence of commercial jet flight is lending urgency to the problem.

In their studies concerning the specific problem of how to quiet a jet engine, BBN scientists have reached this opinion, "Considering current engine design and the method of mounting powerplants in pods slung under the wing, there is now no apparent, reasonable way of quieting a jet engine." By reasonable, they mean without appreciable thrust loss.

Nor is the noise problem posed by jet aircraft restricted to quieting the engines. At altitudes of 30,000 ft., at jet cruising speeds, boundary layer noise in the airplane begins to exceed that of the turbojets themselves, a situation which may call for a weight penalty in soundproofing.

Sound Specialists

BBN is composed of a group of specialists in all phases of sound attenuation and control. They have tackled and solved such diversified problems as silencing the supersonic NACA wind tunnel at Cleveland, designing a huge anechoic (non-echoing) room for General Electric, and doing the acoustical engineering for the auditoriums, conference rooms and broadcasting studios for the United Nations building.

Ideally, a jet's tail pipe should end in a long, thin slit instead of a round hole, says BBN. But a long, thin slit will inevitably produce back pressure and decrease thrust, so the problem remains a knotty one.

Substantiating BBN's opinion that large jet engine noise suppression will be difficult is a statement made by E. E. Callaghan of the National Advisory Committee for Aeronautics, Cleveland, at the Second International Congress on Acoustics recently held at the Massachusetts Institute of Technology. Callaghan reported on research he had done with N. D. Sanders on full-scale jet engines.

"Greatly Alleviate"

"I think that it is becoming increasingly evident that we are going to greatly alleviate the noise problem caused by jet engines," Callaghan said. "There may well be some cost in performance and increased mechanical complication and weight. As yet, it would not appear that we have reached our goal of a minimum of 15 decibels reduction of the maximum sound pressure level.

"Continued effort, however, should make such reductions feasible. The conversion of our crude test devices to finished hardware represents considerable development effort. Furthermore, a great many problems of a practical nature remain to be answered.

At the same meeting, Alan Powell, of the Department of Aeronautical Engineering of the University of Southhampton, England, cautioned that, although this first group of commercial jet aircraft, going into service in 1959 and 1960 may not exceed the noise made by present propeller-driven planes, he did not see that the noise suppression techniques now under consideration would reduce noise sufficienty as plane engines got bigger, more powerful and more numerous. He emphasized the need for more research and the need for a more thorough theoretical understanding of this problem.

20 Decibels Too Noisy

Ground noise made by a four-jet transport at takeoff is 15-20 db. above the accepted tolerance level, according to BBN.

Dr. Leo Beranek, president, said that, because neighborhood tolerance to jet noise varies with its intensity, frequency and duration, it is hard to establish an accurate yardstick of what will and what will not be acceptable. He said:

"It was estimated by Boeing in the corrected version of their paper given this year to the Institute of Aeronautical Sciences that the 707, with four engines at takeoff power, will produce a maximum overall sound pressure level of 130 db. at 900 ft. (Beranek added parenthetically that independent studies made by his company of the Pratt & Whitney Aircraft J57 substantiate this figure).

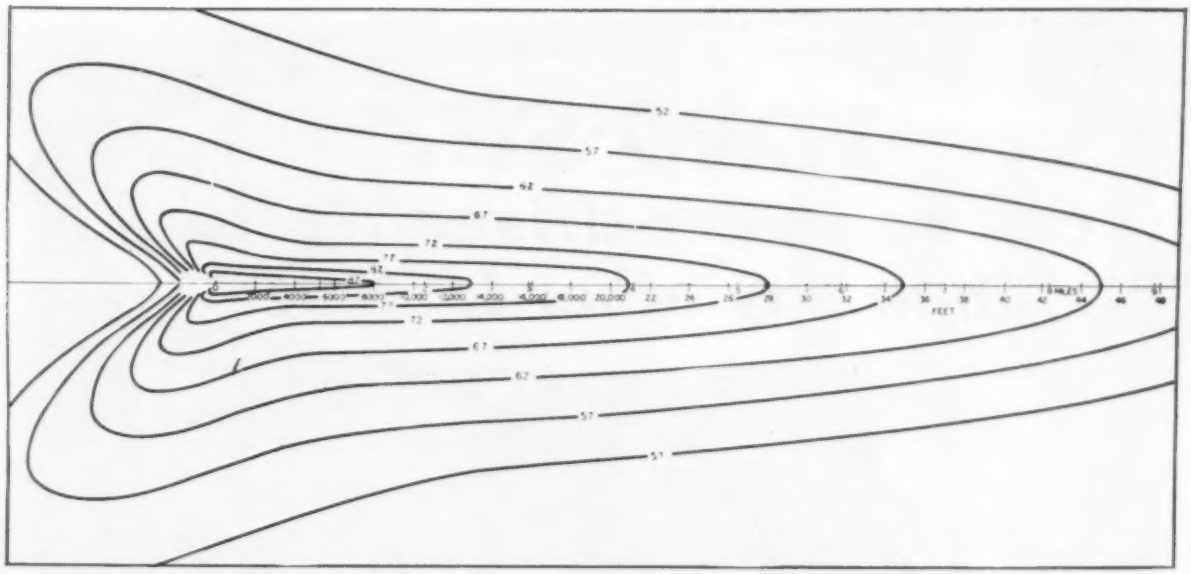
"Assuming an active airport and present-day neighborhood tolerance to airport noise, this level is about 20 decibels greater than currently permissible."

Noise made by the DC-6 series airplane appears to have been accepted by the airlines as the yardstick against which the jets—707, DC-8 and Golden Arrow—will be measured and which they will not be allowed to exceed. In a recent survey made by the Swedish Civil Air Board (AW June 18, p. 107) of the noise level of several different makes of aircraft taking off from Bromma Airport, DC-6Bs' range was 100-116 db., which supports Beranek's statement.

BBN officials cited these three methods of making jet noise more acceptable to those groundlings who have to listen to them:

• **Use a less noisy engine.** Such powerplants as by-pass and low temperature jets are inherently less noisy than the more conventional designs. The by-pass engine, such as the Rolls-Royce Conway, is less noisy because the existing by-pass air reduces the velocity gradient across the exhaust shear plane, quieting the engine. All the noise created by a jet engine at full thrust is caused by the shear along the surface

NOISE POWER	NOISE SOURCE
Million Watts	Future Jet Aircraft
	"Century Series" Jet Fighters
	Commercial Jet Liners
Thousand Watts	Super-Constellation (Take-Off)
	DC-3 (Take-Off)
	Large Pneumatic Riveter
	Large Orchestra
One Watt	10 HP Outboard Motor
	Blaring Radio
	Automobile on Highway
One Thousandth of a Watt	Voice—Shouting
One Millionth of a Watt	Voice—Conversational Level
One Billionth of a Watt	Voice—Very Soft Whisper



CONTOUR plot of jet engine noise is plotted along a scale marked both in miles and feet. Sound levels are in decibels.

between the rushing exhaust and quiescent ambient air.)

By designing a jet which would have a lower total turbine inlet temperature, noise can also be reduced because exit velocity decreases and tail pipe perimeter increases, both being factors which help quiet the engine. Both types of engines will give a noise reduction of approximately 6 db. with no loss in thrust or performance.

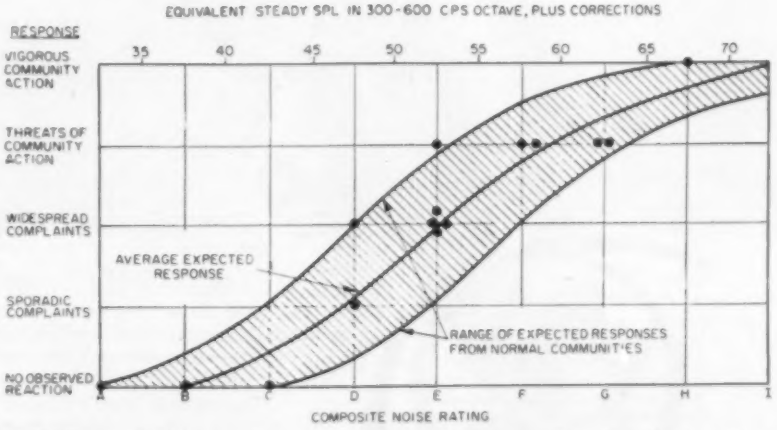
• **Use a noise suppressor.** Depending on the design, tail pipe noise suppressors may be expected to cut jet engine noise by about 6 to 18 db. Disadvantages of noise suppressors are that they will impose a certain weight penalty and will create thrust losses ranging from 1 to 5%, both being undesirable to the airlines. Another factor not to be ignored is that no jet exhaust muffler capable of flying yet exists.

• **Influence the public.** An abstract, psychological factor, but one which may be as effective as the engine type or hardware noise reducers just listed, is an effective public relations campaign which will increase neighborhood tolerance of airport noise 10%.

An unknown factor is whether the different tonal character of jet engine noise compared with piston-engine-plus-propeller will result in a different neighborhood tolerance.

A trend which may mitigate the increased noise of jets is the increasing use of air conditioning, which results in houses being closed both summer and winter. Closed windows and doors do much to reduce noise. This is even more applicable to office and other buildings surrounding the airport.

A noise problem peculiar to jet transports is the fact that, in general



AVERAGE expected community response to intruding noise as a function of noise ratings.

HOW an artist conceives a slit exhaust for a turbojet engine, the most effective silencer.

NEW IDEA FOR AVIATION!

TORQ-SET
can be power-driven tighter than any other fastener

New TORQ-SET, created by American for the aviation industry, can be power-driven tighter than any other fastener.

It can do this because the driving walls of this highly-effective recess provide a direct axis that can be driven at extremely high torque, *yet removed without difficulty*. Furthermore, TORQ-SET is supplied in highly-alloyed steels and the new recess design permits high driving force without burring or distorting.

On-the-job performance has shown consistent, uniformly smooth head surfaces, eliminating the need for refinishing after driving.

TORQ-SET is a product of the same research that developed the famous Phillips Head fasteners. It is produced by American as a completely-forged product, which makes possible unlimited production enhanced by the fine physical qualities of cold forming.

To find out more about how TORQ-SET can solve aircraft fastening problems, write, wire or call American Screw Company, Willimantic, Conn.

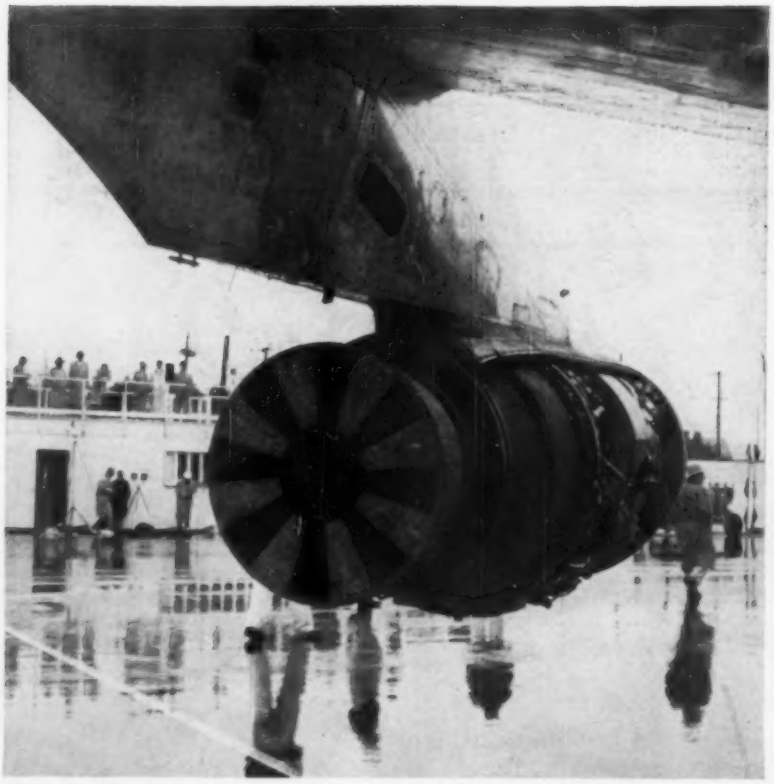
The biggest news in fasteners comes from . . .

AMERICAN SCREW CO. • WILLIMANTIC, CONN.
NORRISTOWN, PA. • CHICAGO, ILL. • DETROIT, MICHIGAN

SINCE 1836

American!

West Coast Sales Office and Warehouse:
Air Industries of California, 922 W. Hyde Park Blvd., Inglewood, California



TOOTHED NOZZLE on one of the Pratt & Whitney JT3-L turbojets powering the Boeing 707 is one of several configurations developed by Boeing engineers to quiet the ground noise level of the four podded powerplants. This demonstration, conducted at a mock-up air terminal built at Boeing Field, was held for the benefit of 50 airline and six Civil Aeronautics Administration representatives. The 707 was started, taxied out, returned to the ramp and parked repeatedly during a three-hour period to simulate operation in today's air traffic. A Boeing KC-97 added traffic load to the simulated ramp and the normal complement of passenger and baggage handling gear was around. Temperature and velocity of the jet exhaust against the building walls were measured.

terms, the "swish" of the boundary layer exceeds the "roar" of the engines at altitudes exceeding 30,000 ft. and at sound frequencies above 600 cps. (Important speech range is about 300-5,000 cps.). At 40,000 ft., engine noise boundary layer noise will predominate completely.

Beranek cited these reasons for jet engines becoming quieter at cruise altitude:

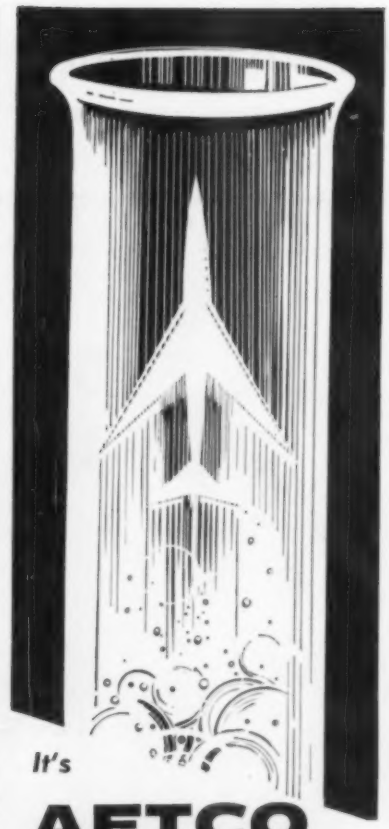
- **Less air** (the air being rarer) is pumped through the engine, therefore less noise is generated in the shear plane.
- **Lower velocity** gradient exists across the shear plane since the forward motion of the aircraft reduces the relative speeds of exhaust and ambient air by an amount equal to the speed of the aircraft.
- **It is harder** to generate noise in rarefied air because the air "slides by more easily when rarefied."

Conversely, at low altitude and high engine thrust, the powerplant's roar will be the disquieting noise, particularly in the rear of the plane during take off and climb. BBN officials believe that it will take about twice as much sound-proofing (in terms of weight) to quiet the roar of a commercial jet's cabin than is required in a piston engine plane. However, the same men emphasize they see no unsolvable problem to quieting the interior of jets—the real problem lies outside.

Since, at takeoff power, 100% of all noise produced by a jet engine is generated behind the engine, all muffling schemes are concerned with this noise and any sound created within the engine itself is discounted.

The noise is caused by air turbulence occurring at the shear surface between the exhaust air blasting through the still, surrounding air. Highest frequencies occur at the engine exhaust where the turbulence shear line between exhaust and ambient air is relatively narrow. Width of the shear line increases as it recedes from the engine tail pipe and the frequency becomes correspondingly lower.

Noise power produced in the exhaust



It's

AETCO

for complete testing of aircraft components

Some of America's largest aircraft corporations rely regularly on Aetco services . . . to achieve quick qualification of products for use on production line . . . and to free company engineering personnel for other projects.

WRITE FOR BOOK:
"How Aetco can help you."

Aetco

AIRCRAFT EQUIPMENT TESTING COMPANY
1806-12 FLEET STREET
BALTIMORE 31, MD.
America's First Independent Aircraft Testing Laboratory
Hydraulic, pneumatic, electric (400 cycle, AC-DC) and mechanical
IN FLIGHT TESTING!

Navy's first primary jet trainer by Temco

Ready today for training tomorrow's jet pilots

Now it's jet training from the ground up!

Temco's two-place jet trainer — the Navy's TT-1 — opens up an entirely new concept in military flight training. Now, student pilots can actually begin their training in a jet aircraft.

Temco developed its fighter-type trainer to give fledgling pilots jet wings at the very start . . . to shorten the number of hours required for military flight training programs. Outstanding safety features, ease of handling, plus the flight characteristics of true jet performance make the TT-1 today's most efficient answer to the needs of military training commands.

The TT-1 will be a "new" aircraft tomorrow and for years to come, thanks to its carefully engineered growth factor. Temco designed its rugged trainer to permit important up-to-the-minute changes with only minor modification.

Proving its worth in competitive flight evaluation tests at the Patuxent River Air Test Center, Temco's jet trainer won its Navy wings in June to bring closer the day when a cadet flyer's first solo will be jet-powered.

Engineers: Openings in all phases of aircraft design and development; write to Joe Russell, Engineering Personnel, Temco Aircraft Corporation, Dallas, Texas.

TEMCO®

AIRCRAFT CORPORATION, DALLAS

tomorrow's opportunities...

for today's engineers

Tomorrow's opportunities are opening up right now at Temco—and today's engineers are needed to fill them.

You'll never get "lost in the shuffle" at Temco. Its dynamic pace and rapid expansion leave no room for unused ability, wasted work. Your chance to grow with Temco is limited only by your own talents and training. It's the kind of place where you can begin today building for tomorrow's security. Want actual proof of your opportunities to grow with us? Write:

Engineering Personnel, Dept. C
Temco Aircraft Corp.
Box 6191 Dallas, Texas

Opportunities now in:

- Structural and mechanical design
- Aerodynamics
- Flutter and vibration studies
- Structural, servo, environmental and electronics test laboratories
- Standards
- Technical writing
- Materials and processes

TEMCO
AIRCRAFT CORPORATION, DALLAS

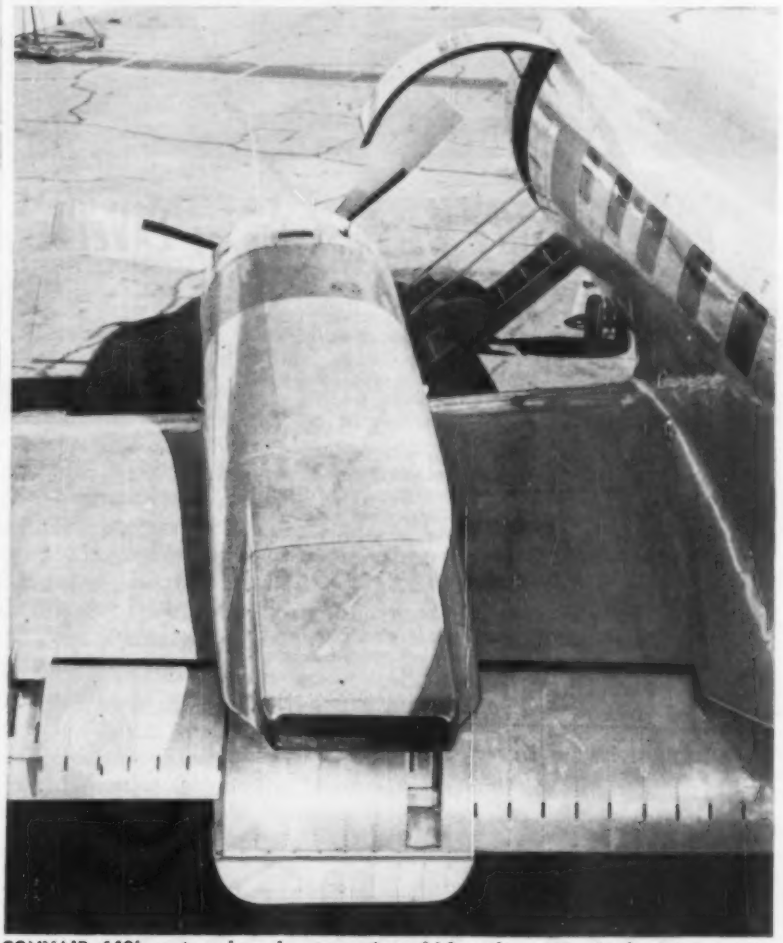
of a jet engine fitted with conventional, circular tail pipe increases with the 8th power of the exit velocity of the exhaust gas. Therefore, any slight increase in the tail pipe's perimeter, transverse to the axis of the engine, will result in an appreciable reduction in noise because of the lowered velocity gradient between exhaust and ambient air. Ideal way to increase the tail pipe's perimeter is to flatten it into a long, thin orifice—a "slit exhaust" generally similar in shape to the rectangular trailing edge exhaust the firm developed for the very quiet Convair 440 Metropolitan. As Beranek put it, "We believe that an improved jet engine from the noise standpoint would result if the exhaust . . . could be made in the form of a long, thin slit. Where this slit could go on an airframe, and meet all the other requirements of the airframe and powerplant design is really beyond our province. . ."

The slit shape is more effective than the flower configuration proposed by Boeing to the IAS earlier this year (AW Jan. 30, p. 28), according to Beranek, because the noise coming out of the flower type silencer tends to regroup, thus partially nullifying the effect of the device.

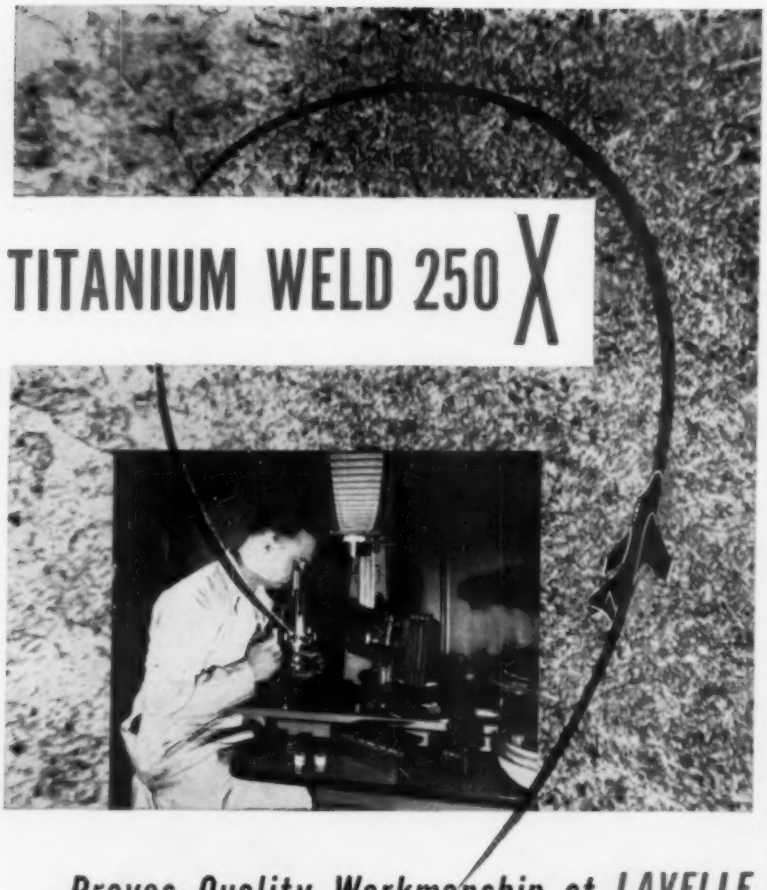
BBN acoustic experts have done so much work to quiet wind tunnels they have reduced the difficult science to an almost routine job. As they put it, "We have gotten to the point where we can calculate the amount of noise you can expect out of a given wind tunnel."

A major accomplishment in this field was the noise control work the firm did for the world's largest supersonic wind tunnel, the 6 x 8 ft. tunnel operated by the NACA at Lewis Flight Propulsion Laboratory in Cleveland. When the tunnel was first opened, its electrical power requirements were so great that it could only be operated late at night, while Cleveland residents slept.

With the original sound-proofing,



CONVAIR 440's rectangular exhaust opening which replaces two circular jet augmenter tubes is new sound improvement program. New muffler, inner cabin window assemblies in first eight rows of seats, application of acoustical tape to some interior surfaces, addition of fiberglass soundproofing, are all part of sound lessening program for 440.



TITANIUM WELD 250X

. . . Proves Quality Workmanship at LAVELLE

The microscopic inspection equipment and actual photomicrograph of a titanium automatic heliarc butt weld 250x, shown above, are typical of the quality control techniques employed by Lavelle to assure *production perfection* of critical parts and components for the aircraft industry.

Advanced facilities and methods for welding titanium and high temperature nickel and steel alloys . . . Government Certified technicians and equipment . . . *plus* careful inspection and follow-through by experienced specialists at every stage of production, add up to greater speed, efficiency and economy in meeting customers' exacting specifications at Lavelle.

Learn how this *complete* service proves the quality workmanship of the precision components you require . . . when you call on Lavelle for your fabricating needs.

Additional data on Lavelle's specialized fabricating services is contained in this illustrated brochure. Write for a copy without obligation.

Lavelle

LAVELLE AIRCRAFT CORPORATION • NEWTOWN, BUCKS COUNTY, PA.

the growl of a ram jet could be heard 10 miles away. Neighborhood reaction was quick and angry. After BBN's additional noise control structure was added, a man walking past the tunnel's exit could tell whether or not it was operating only by feeling the exhausting hot air; all noise has been muffled.

Currently, wind tunnel projects are under way for these companies: two for Douglas, and one each for Convair. North American, Boeing, and Arnold Engineering Development Center.

In the same vein, BBN has designed over 200 jet test units for dozens of engine and airframe manufacturers and for the USAF.

Another important facet of BBN's work is in determining the effects of aircraft noise on airport planning and on the surrounding community.

The firm has been advising the Port of New York Authority for several years on this problem. It still is making many surveys for the military for such purposes as location of new housing near an air base.

The main criterion of noise acceptability is SIL (speech interference level). If noise consistently interferes with speech, the public gets angry. The higher the frequency of interference, the more violently the public reacts.

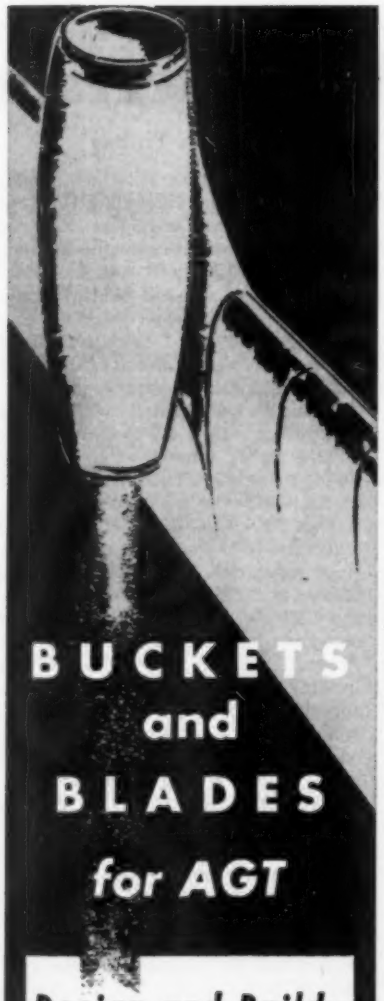
Another big objection to noise (exclusive of a fear connotation such as might have been generated at Newark where residents had reason to associate aircraft noise with crashes and loss of life) is disturbance of sleep.

Aside from the multi-million dollar anechoic room for GE, which measures 59x49x44 ft. and has walls 18 in. thick, BBN has done these non-aviation jobs: served as acoustics and noise control consultants for General Motors new $100-million Technical center; quieted the latest Evinrude and Johnson outboard motors; provided noise elimination and control recommendations for the experimental lightweight Talgo "X" train; undertaken noise control studies on pre-fabricated houses for U. S. Steel Corp.; designed Diesel locomotive horns to sound like steam whistles (actual steam whistles required too large a volume of air to be effective).

The company also has done interior acoustical design for such halls as the Kresge Auditorium at M.I.T., the World Zionist Congress Building in Jerusalem and the Aula Magna Auditorium of the University of Venezuela in Caracas.

BBN was formed by R. H. Bolt and L. Beranek in 1948. Both men, plus R. B. Newman and another member of the firm, J. J. Baruch, are on the faculty of M.I.T. besides managing BBN.

The firm grosses $500,000 a year, strictly in acoustical consulting; it produces no hardware.



BUCKETS
and
BLADES
for AGT

Design and Build:

- Forge Dies
- Trimming Dies
- Investment Molds

Machine to *✓

- Forgings
- Solid Stock
- Investment Castings
- Centrifugal Compressor Wheels

*Your specifications

AIRFOIL DIVISION

Therm-electric
METERS CO., INC.
Ithaca, New York

MALLORY·SHARON reports on

TITANIUM

How a **METAL IMPROVEMENT** *helps maintain B-52 production schedules*

• Here's the Boeing B-52 global bomber . . . flying 400 pounds lighter because the new metal titanium is used extensively in the jet engine pods. But in forming titanium parts, Bell Aircraft, one of the firms which produces the complete pod assemblies, originally encountered production delays because of variable "springback" in forming titanium sheets of different strengths.

To overcome this, Bell segregates titanium into different strength groups, which are color coded and handled separately with improved forming techniques. Here Mallory-Sharon's new "quality certification" of titanium proves a substantial time saver. With this method, we not only meet specifications, but certify average strength of each heat we produce, and certify that 97.5% of each heat is in a narrow range of this average. This eliminates the need for tests to segregate incoming material . . . helps cut fabrication costs . . . and permits meeting production schedules on time.

Quality certification is another first from Mallory-Sharon . . . a leading producer of titanium and titanium alloy mill products. Call us for your requirements in this lightweight, strong, corrosion resistant metal.

MALLORY-SHARON TITANIUM CORPORATION, NILES, OHIO

MALLORY Ti SHARON

Russian Engineering Education—Part 3:

Soviet Aircraft Training Well Integrated,

By Leon Trilling*

The vertical integration of all facilities and functions—including the training of specialists under the various industrial ministries is especially thorough in the Soviet aircraft industry. Aside from the historical and political factors which have led to the development of vertically integrated industrial complexes under each ministry, the requirements of military security have made it desirable that all research, planning and production within the aircraft industry of the Soviet Union be concentrated under a single leadership and known to as restricted a group as possible.

The Soviet aeronautical industry is embraced in a closely knit complex of three ministries, the Air Force (an air branch of the Ministry of Defense) and the Civil Aviation Ministry as the only customers, and the Ministry of Aircraft Production as the only producer. The training of aeronautical engineers, the administration of aeronautical research laboratories, and the publication of aeronautical technical literature are wholly in the hands of these ministries.

The Air Force and Civil Aviation Ministries specify the performance requirements of any given aircraft, the Air Force playing by far the leading role in this respect, not only because it orders almost the totality of the production but also because regulations require that air transports and passenger aircraft be adaptable to military use with a minimum of effort. The Air Force, therefore, needs and trains a rather large corps of military air engineers particularly skilled in development work, in general design and perform-

MIG-17 AND BADGER formations are used as the backdrops for these pictures of Russian pilots in their press. MIG-17 squadron (top) has tail flash in red extending forward along the fuselage to nose. Seven Badger medium jet bombers show first closeup of rear gunner position, with visual observation panels below a small radome. Blister on airplane behind head of fourth pilot from right is unidentified, could be a housing for drogue chutes.

But Party Plays Heavy Role

ance evaluation, and in actual prototype testing. It also trains air engineering officers skilled in the techniques of aircraft repair and maintenance.

This training takes place at three military air academies: the Zhukovskii Military Air Academy in Moscow, the Air Engineering Academy in Leningrad, and the Military Air Engineering College in Riga. The Zhukovskii Academy, founded in 1923 in response to the suggestions of the great Russian aeronautical scientist, N. E. Zhukovskii (1847-1921), and the most important of the three, is very active in research and development on aircraft and other weapons, and trains highly skilled engineers. The Leningrad Academy concentrates on aircraft designers and also maintains a high standard. The Riga Air College specializes in maintenance problems.

On the graduates of the Zhukovskii and Leningrad Air Academies rests the responsibility of deciding what type of aircraft can or should be produced and whether a given prototype fills the bill of particulars. Since their technical competence and judgment determine the quality of the equipment of the Red Air Force, these men are selected and trained with exceptional care.

Elite Institution

The Zhukovskii Air Academy is an elite institution to which every year some 1,600 unusually able and reliable young engineering students or engineers are assigned by the Communist party. It is not possible to apply or compete for entrance to the Academy; admission is by party invitation only. Upon admission the young men receive a commission in the Red Air Force Engineering Corps which apparently varies between the rank of lieutenant and captain, depending on previous experience and record. Since they draw military pay and are entitled to uniforms, room, and board at government expense in addition to the equivalent of PX privileges, their material situation is far better than that of a civilian undergraduate or even graduate student.

The course at the Academy, which lasts five years, is almost entirely on a highly advanced level, the students having already completed or nearly completed their regular course before admission. The teaching is by leading scientists some of whom are members of the Academy of Sciences and many of whom hold simultaneous senior professorships at Moscow University or at the Ordzhonikidze Moscow Aeronautical Institute.

Pay scale is higher by 40% at the Zhukovskii Academy than in civilian institutions, except for senior professors, for whom this may be less important in view of their many other sources of income. Until his death last year, V. V. Golubev, head of the Mathematics-Mechanics Faculty of Moscow University, held the Mathematics Chair; the Chair of Aerodynamics has been held for many years by Professor B. N. Yurev, student of Zhukovskii and senior Soviet applied aerodynamicist.

Not Easily Evaluated

Since military security forbids extensive publication on aeronautical engineering subjects, the creative achievements of the Zhukovskii Academy staff are not easily evaluated; but some idea of their qualifications may be gained by a study of the textbooks which they have published. Approximately one-third of the Soviet aeronautical textbooks available at the Libarary of Congress have been written by members of the staff of the Zhukovskii Air Academy, notable among them B. N. Yurev's three-volume *Applied Aerodynamics*, which is a standard required textbook in all Soviet aeronautical institutes.

Other Zhukovskii Academy staff members who have written extensive textbooks include B. N. Goroshchenko (performance of high speed aircraft), Gudtsev (metallurgy), and A. A. Umanski (airplane design).

The Air Academy consists of four principal technical departments or faculties, namely, in order of importance and of prestige among the students:

- **Aeronautical** Engineering Design and Performance
- **Aircraft** Equipment (in particular, electric, electronic, and hydraulic)
- **Armament**
- **Administration**

The Faculty of Aeronautical Engineering, which teaches aircraft designing and design evaluation, is primarily concerned with applied aerodynamics—the study of air loads and their effect on the stability and control of an aircraft; the performance, speed, range and rate of climb of the aircraft when powered by a specified engine. It also deals with problems of general design layout and with calculations of strength and rigidity requirements.

The Faculty of Aircraft Equipment teaches the arrangement and design of mechanical, electrical, and hydraulic control systems, landing gears, servomechanisms, and, increasingly in the last few years, considers problems of electronics and guidanee.

The Armament Faculty deals with design and installation of conventional aircraft armament.

The Faculty of Administration trains the students in managerial skills and gives them the information they need on the organizations which they will be called upon to serve and to direct.

There is also, of course, the inevitable political department, which, in view of the prominent positions graduates of the Academy are likely to assume, is more extensive than in the average institution of higher learning. Not only does it teach compulsory courses in Marxism-Leninism, the history of the Communist party, political economy, and dielectical materialism; it also sponsors many "voluntary" seminars and discussion sessions on current events, and it closely supervises even leisure time and personal life of the students.

On entering the school, the students (or "cadets," as they are called while at the Academy) are divided into groups of twenty to twenty-five who attend recitations and do laboratory exercises together. The entire student body attends formal lectures together in the first two years. The first year they receive training in the basic sciences (mathematics, physics, etc.), which are treated as service courses not deserving a department of their own. From the middle of the second year on specialization starts, with much emphasis on individual work often related to practical weapon development programs.

Some Teach

Although the graduates of the air academies are engineering officers, they do not all pursue military careers. Some become teachers. Melnikov is a professor in Leningrad. Pogorelov is a docent at the Kharkov Aeronautical Institute. Zaks is a docent at the Central Asian Polytechnic Institute in Tashkent, where, since there is no aeronautical faculty or aeronautical institute in Tashkent or anywhere nearby, he is presumably in the Mechanical Engineering Faculty, thus demonstrating a degree of versatility and supporting the party policy of strengthening outlying educational institutions by bringing in able, energetic young men. Other alumni become senior designers, and some, Gurevich and Yakelev, for instance, have gained great reputation.

The Air Academy graduates play a fundamental role in setting the design philosophy of the Soviet aviation industry, either by designing prototypes or by

---

* *Leon Trilling, assistant professor of Aeronautical engineering at Massachusetts Institute of Technology.*

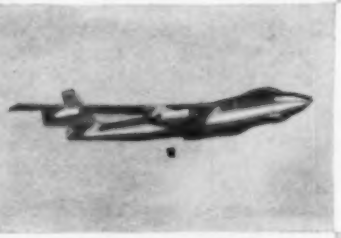
***Lockheed Electra**—equipped with a Honeywell Transistorized Fuel Gage.*

***Martin XP6M-1 SeaMaster** equipped with a Honeywell Transistorized Fuel Gage.*

***Martin RB-57B Canberra** equipped with a Honeywell Transistorized Fuel Gage.*

***Cessna T-37A**—equipped with a Honeywell Vacuum Tube Gage.*

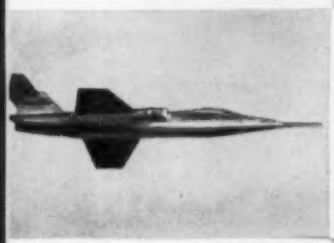
***Fairchild C-119**—equipped with a Honeywell Vacuum Tube Gage.*



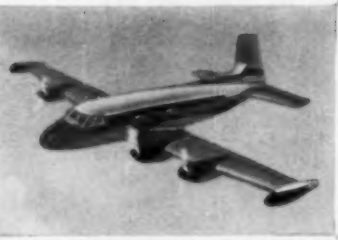
***Boeing B-47**—equipped with a Honeywell Vacuum Tube Fuel Gage.*

***Douglas DC-7C**—equipped with a Honeywell Transistorized Gage.*

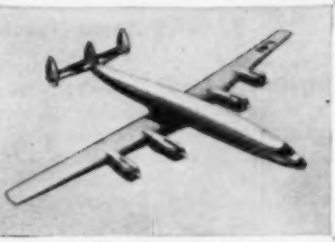
***Vertol H-21**—equipped with a Honeywell Transistorized Fuel Gage.*



***Lockheed F-104A Starfighter** equipped with a Honeywell Transistorized Fuel Gage.*



***Cessna 620**—equipped with a Honeywell Transistorized Fuel Gage.*



***Lockheed 1649A Super Constellation**—equipped with a Honeywell Transistorized Fuel Gage.*

***Douglas DC-6B**—equipped with a Honeywell Vacuum Tube Gage.*

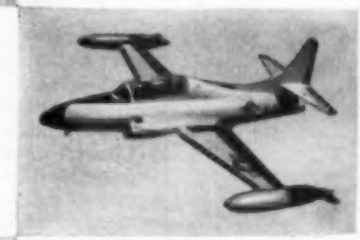
***Lockheed C-130A Hercules** equipped with a Honeywell Vacuum Tube Fuel Gage.*

***Convair XFY-1 Pogo**—equipped with a Honeywell Vacuum Tube Gage.*

***Convair 440 Metropolitan** equipped with a Honeywell Vacuum Tube Gage.*

***Convair 340**—equipped with a Honeywell Vacuum Tube Gage.*

Lockheed 1049G Super Constellation—equipped with a Honeywell Vacuum Tube Gage.



Lockheed T2V-1 SeaStar equipped with a Honeywell Transistorized Fuel Gage.

Martin P5M Marlin—equipped with a Honeywell Transistorized Gage.

Avro CF-100 Canuck—equipped with a Honeywell Vacuum Tube Gage.

Grumman F11F-1 Tiger equipped with a Honeywell Transistorized Fuel Gage.

Boeing 377 Stratocruiser equipped with a Honeywell Vacuum Tube Gage.

Boeing 707 Jet Stratoliner equipped with a Honeywell Transistorized Fuel Gage.

Sikorsky S-56 Helicopter equipped with a Honeywell Transistorized Fuel Gage.

Today's standard of measurement—

ELECTRONIC FUEL GAGE BY HONEYWELL

Today, on practically every major aircraft—both commercial and military—you'll find a Honeywell Fuel Gage.

Lightweight, compact and ruggedly built, Honeywell Gages are adaptable to every type of installation and flight characteristic.

The universal preference for Honeywell Gages to perform the vital function of fuel measurement is based upon a number of excellent reasons—of which unquestionably, *reliability* and *accuracy* are foremost.

Honeywell assures reliability through the highest standards of quality control, plus endless operational testing.

And whether it's a Honeywell transistorized fuel gage, or a Honeywell vacuum tube gage, it has pin-point accuracy that can measure any fuel load to within two percent—even under the most severe operating conditions.

In addition to the many aircraft shown here, other representative aircraft that fly with Honeywell Transistorized Fuel Gages are: Grumman F9F-8 and F9F-8T, Avro CF-105, Ryan Model R-69, Convair B-58, Boeing KC-135, Bell H-40.

For further information about Honeywell Gages and other automatic fuel system controls, write Honeywell, Dept. AW-9-215, 2604 Ridgway Road, Minneapolis 13, Minnesota.

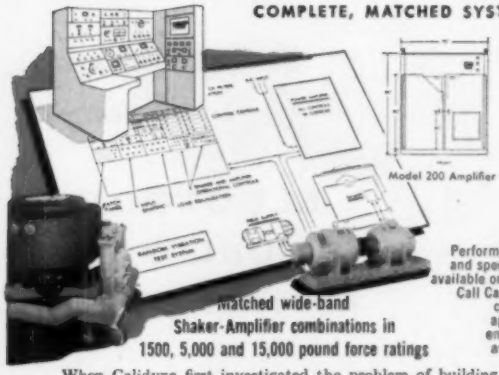
MINNEAPOLIS
Honeywell

AERONAUTICAL DIVISION

for Random Vibration Testing:

CALIDYNE'S NEW

COMPLETE, MATCHED SYSTEMS



Performance data and specifications available on request. Call Calidyne for competent application engineering assistance.

Matched wide-band Shaker-Amplifier combinations in 1500, 5,000 and 15,000 pound force ratings

When Calidyne first investigated the problem of building random vibration test systems, it recognized the necessity of over-all system engineering, if desired performance levels were to be achieved. That goal has now been met in what is probably the first *complete, integrated* system comprised of *matched* components.

"Wide-Band" *electrodynamic Shakers* operate at higher frequencies on lower input power, for a given armature weight and matched load rating. In random testing the load approximates the armature weight, and inherent armature rigidity maintains a high first resonance. The new *Random Noise Amplifiers* are matched power sources for the "wide band" Shakers. Made by Westinghouse to Calidyne specifications, they provide ample power for continuous duty operation at full performance. At the same time they are capable of supplying instantaneous power peaks for random noise tests.

The *Model 188 Console* is a typical control unit for any of several systems. It contains basic Shaker-Amplifier operating controls, input shaping and compensation circuits, plus monitoring and other control equipment. With these components, Field Power Supplies complete the over-all system.

THE CALIDYNE COMPANY

330 CROSS STREET, WINCHESTER, MASSACHUSETTS

There's a Stillman representative near you...

...with the answers to your O-ring, rubber-to-metal bonding and rubber molding problems. Ask him about PERMADIZING, Stillman's exclusive high-quality rubber-to-metal bonding process that provides precise, flash-free parts of optical smoothness. Write or call your nearby Stillman representative today.

Stillman has the answer...
PERMADIZING

Stillman Rubber Co.

5811 Marilyn Ave., Culver City, Calif.
23525 Lorain Rd., Cleveland 26, Ohio

writing the specifications to which prototypes are built. They are prepared for that important responsibility both by a thorough, up-to-date, broad technical education and by an indoctrination program which not only stresses loyalty to the regime but apparently also installs pride, *esprit de corps*, and a sense of leadership and responsibility.

Basic research is not the administrative concern of the universities or of the Ministry of Higher Education. It is primarily the responsibility of the Academy of Sciences of the Soviet Union, a body made up of the leading scientists in all fields of research and development which reports directly to the Council of Ministers and is assigned a large annual budget to sponsor research at a number of Academy research institutes.

However, the separation between universities and research institutes is more apparent than real, since the same man may in the morning lecture at the university and in the afternoon supervise research in the same field at a research institute.

This "multiple hat" system in which leading academic personnel carry several responsibilities appears, from the available testimony, to operate with flexibility and effectiveness.

Scientists engaged in the fundamental research which underlies the whole problem of flight do their work both at the universities and at the Academy-sponsored research institutes, where they are faculty or research staff members. The younger staff members are research engineers and *aspirants* or graduate students who act as part-time research assistants; the others spend part of their time as docents or professors and part as research fellows or senior research personnel.

It is apparently almost a universal rule that the time of the academic personnel is divided between teaching duties and research. All in all, they form a numerically small, privileged group in the Soviet Union and enjoy high prestige and an excellent standard of living, with high earnings, eight weeks of yearly paid vacation at a designated resort, and other advantages.

Compared to a worker's wage of about 800 rubles per month, the monthly pay scale for academic personnel is as follows:

- **Civilian Institute or University**—Assistant, 900/1200 rubles; Docent, 1300/1700 rubles; Professor, 1700/2100 rubles.
- **Military Institute**—Assistant, 1500/1700 rubles; Docent, 2000/2400 rubles; Professor, 2000/2400 rubles.

In addition, there is a 20 per cent bonus if the individual has the title *Kandidat Nauk*, an extra 10 per cent for the title *Doktor Nauk*, and an extra

300 to 500 rubles for administrative responsibilities for laboratory heads or professors in charge of a chair. It appears from this table that the income of an academic worker is two to five times that of an industrial worker.

Furthermore, since it is standard practice to hold at least two jobs simulaneously, and the attendance regulations (especially for senior staff members) are not strict, it is possible (and usual) to draw two salaries. A senior professor in charge of a laboratory might thus draw up to 7000 to 7500 rubles per month, and his consulting and book-writing activities may boost the total still higher.

Salaries Doubled

The figures quoted above are as of 1948. Apparently they have all been approximately doubled since, presumably in connection with the revaluation of the ruble.

Note the significantly higher pay rate at military institutes, an additional indication of the select place which they occupy in the over-all scheme.

While assistants work an eight-hour six-day week, docents and professors have a maximum work load of four lecture hours and four consultation hours per week, the rest of their time being taken up by research, administrative work (including sitting on numerous academic and government committees), and consulting.

It is the rule for a docent or a professor to prepare his own course rather than follow a specified textbook step by step. This involves the preparations of notes which frequently end up by being published as textbooks. The practice of writing textbooks apparently approved by the state, is both an appreciable source of revenue for academic personnel and, in view of the great difficulty of publishing research papers, the best means of making themselves known.

The present policy (at least in technical fields) appears to be to encourage the publication of a number of textbooks of slightly different viewpoints; and the number of texts in any subject tends to be quite large. (Five on advanced applied aerodynamics are known to this writer.) There is also much writing of monographs and treatises.

Because of the scarcity of available official information on the technical content and quality of the education of a Soviet scientist engaged in teaching and research in the manner just described, the discussion which follows is limited to an analysis of certain advanced-course Soviet textbooks and some observations on the range of activities of graduates of a particular chair, namely, the Chair of Fluid Mechanics.

Of the numerous textbooks examined

Marquardt's research center is fast becoming one of this country's creative engineering capitals. Unlimited opportunities at Van Nuys are attracting many Research and Development engineers to Marquardt.

Write for details:

PROFESSIONAL PERSONNEL
16551 Saticoy Street, Van Nuys, California

THE WEST'S LARGEST JET ENGINE RESEARCH AND DEVELOPMENT CENTER

Here, at last is a mask hose connector that automatically closes when disconnected, causing a noticeable increase in breathing resistance. This increased breathing effort serves as an immediate warning signal to the wearer of the oxygen mask that he has become disconnected from his oxygen supply. The MC-3 connector incorporates the standard fitting for attaching the oxygen bail-out bottle. It is also interchangeable with present disconnects. You're safe with the Scott MC-3 connector!

Write today for complete information.

SCOTT AVIATION CORP.

275 ERIE STREET, LANCASTER, N. Y.

EXPORT: SOUTHERN OXYGEN CO., 15 WEST 57th STREET, NEW YORK 19, NEW YORK

in the course of this study, two were selected to orient the discussion both because they illustrate Soviet research in theoretical fluid mechanics and because they are quoted often enough in the technical literature to indicate that they are in fact part of the technical baggage of most of the younger scientists. They are *Theoretical Hydromechanics* by Kochin, Kibel, and Rosé; and *Mechanics of Continuous Media* by Landau and Lifshitz.

In general, in order to absorb the material presented in the two basic monographs a student must have an excellent knowledge of classical mathematical analysis, probably the equivalent of what an advanced graduate would obtain in the United States; a broad view of the laws of analystical mechanics and their application to a number of widely different physical situations; and, last but not least, considerable sophistication and maturity in the handling of his mathematical tools.

Specifically, *Theoretical Hydromechanics* outlines in great detail the principal mathematical methods of use in fluid mechanics: functions of a complex variable, expansions in orthogonal functions, method of characteristics, numerical methods, and so on. Each technique is illustrated by exhaustive application to one or several selected problems of practical interest which are treated thoroughly enough to allow engineering applications.

Mechanics of Continuous Media shows the range of applications of the science of fluid mechanics by presenting typical problems in the fields of aeronautical, mechanical, hydraulic, and chemical engineering; in meteorology, acoustics, oceanography, geophysics, astrophysics, low temperature physics, and chemistry. This astonishing breadth precludes detailed treatment of any single subject but gives the reader an insight into the unity of the field which underlies all the applications and suggests why fruitful analogies and ways in which techniques may be grafted from one application onto another.

Certain solutions for supersonic flows past cones, first studied in Germany in 1942 and in the United States in 1946, for instance, were noted in the Soviet Union as simple applications of a solution of a geophysical problem involving a completely different physical backround (Smirnov and Sobolov —1932).

It should be noted that both skill in mathematics and a broad outlook in classical mechanics have been part of the Russian scientific tradition since well before the Revolution and were applied with success to many problems in fluid mechanics and aeronautics by N. F. Zhukovskii (1847-1921) and his principal student, S. A. Chaplygin (1869-1942). Both of these men

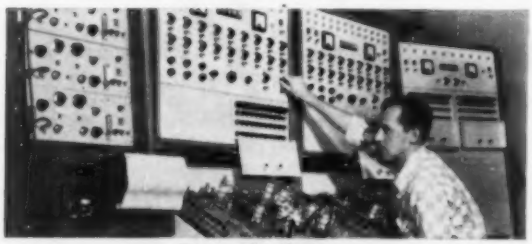
"What do you need for a successful engineering career?"

Frank W. Fink, V.P., Chief Engineer

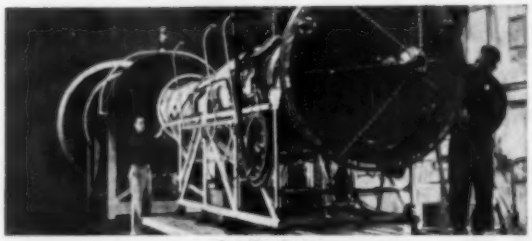
Your future is brighter at Ryan because of this *unique* combination of advantages:

Jet Aircraft

Jet Drone Missiles



Electronics Systems



Jet Engines

DIVERSIFICATION – Ryan is in *all* fields of aviation – *Airframe – Propulsion – Electronics.* 80 percent of Ryan engineering is challenging design work in Jet VTO – Global Navigation – Jet Drones – Missile Guidance – New Planes – Missiles – Jet Engine Metallurgy and Rocket Combustion.

SIZE – With 750 in the Engineering Division, Ryan is big enough to be diversified – small enough to be closely knit. You will get stimulating, broad experience – never feel "lost in the shuffle."

STABILITY – In 33 years, Ryan has designed and produced 25 different aircraft, missiles, drones and pioneered in jet propulsion – afterburning – CW Radar.

GROWTH – Ryan Engineering Division has tripled in three years. Ryan leads in Jet VTO – Automatic Navigation – other fast-growing fields.

CLIMATE – You will enjoy sunny, clear-sky San Diego where *living is unlimited* – where the world's best climate lets you swim, yacht, ski, golf, fly the year 'round. Where beaches, mountains, parks are minutes away.

Ryan needs all types of Aeronautical and Electronics Engineers, Designers, Analysts, Specialists. Invest in your future. Act now by sending in the coupon below. All replies are strictly confidential.

Mr. James Kerns
Engineering Division, Ryan Aeronautical Company
2706 Harbor Drive, San Diego 12, California

Dear Sir:
Please send me your free illustrated engineering brochure.

Name_____

Address_____

_____

RYAN AERONAUTICAL COMPANY

reached maturity and occupied positions of influence in the Imperial university system; and their labors laid the basis of aeronautical research and development in Russia before and after the Revolution. The tradition of mathematical skill and versatility is preserved to the present day in the Soviet Union, as some examples will show.

Three Men Selected

Among the senior teaching and research personnel, three men may be selected as typical of the Soviet effort in theoretical fluid and gas dynamics. L. I. Sedov (born around 1895) is an applied mathematician with a dazzling technique. He was connected with TsAGI in the 1930's and has been a professor of mechanics at Moscow University since the late 1930's and a member of the Academy since the 1940's. He has made significant contributions to the theory of the lift of wings (1932-1937), of ship wave motion (1937), and of the impact of hard bodies on a free water surface, both singly (1934) and with several students (1950-1953). When high-speed flight became a practical prospect, he attacked the aerodynamic problems which it raised, at first with limited success (1937-1940).

In 1942 he gathered a group of young scientists who, under his guidance, worked out the general theory of supersonic flight of thin wings and bodies (1942-1946). He has since shown a fleeting interest in turbulence (1942) and has undertaken a searching study of dimensional analysis and similarity in mathematics and physics, applying his results to the problem of very strong blast waves (1940-1952). He was appointed chairman of the Academy commission for an earth satellite and, as such, represented the Soviet Union at the recent international astronautical conference in Copenhagen.

S. A. Christianovich (born in 1908), a star pupil of S. A. Chaplygin, did his first important work in 1935-1942, an extension of Chaplygin's calculation of gas jets so that it could be used to determine the performance of wings of any shape at speeds nearly up to the speed of sound. He played an active part in wartime research and has since taken the role of a senior statesman in fluid mechanics, a position bolstered by his recent election as chairman of the technical section of the Academy.

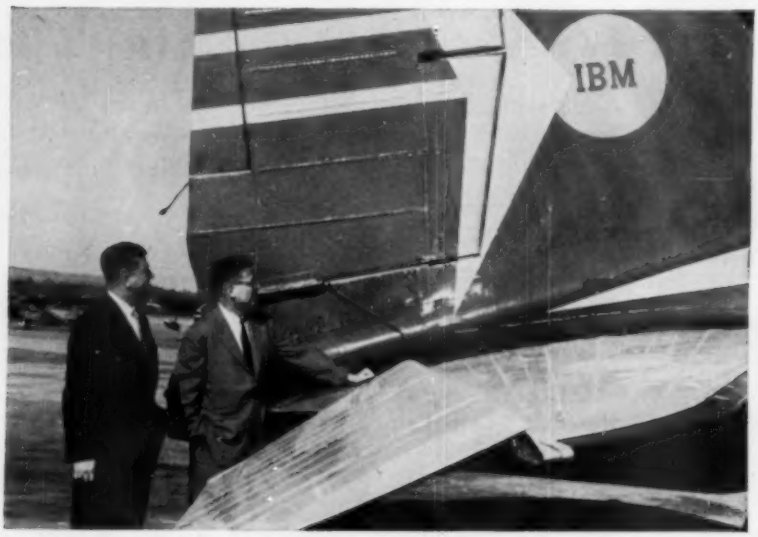
Christianovich Papers

Christianovich has in the last five years presented or sponsored papers on subjects of interest in chemical engineering (Gas Flows in Pipes with Heat Addition and Suspended Particles—1950), electrical engineering ("Problems related to the Construction of the Kuibyshev Power Plant"—1953), mining engineering (Effect of High Pressure Pockets on Rumbling of Coal).

V. V. Golubev was born in 1884 near Volokolamsk, where his father taught Latin in a parochial school. After a brilliant secondary school education during which he showed an interest in mathematics and the natural sciences, he entered Moscow University in 1903 and graduated in 1908 in mathematics. He then divided his time between research, graduate study at the University, and teaching simultaneously at several public and private high schools, and obtained his master's degree in mathematics in 1915. In 1917 he was appointed Professor of Mathematics at the University of Saratov (founded in 1909 and later vastly expanded), where he became Dean of the Mathematics-Physics Department in 1918. Just then, as he was readying a doctoral dissertation on singular differential equations, all academic titles were abolished (1919).

Circumstances then forced him to take an interest in less abstract researches, and in 1924-1927 he began a study of lifting wing theory. After 1920 he also taught mathematics at the Saratov Institute of Agricultural Science, and he eventually published his lectures "Principles of Mathematical Statistics Applied to Forestry" (1930).

In 1930 he joined the research staff



IBM Can't Afford Downtime!

With a limited number of airplanes and a large number of flights—IBM just can't afford unscheduled downtime. Airwork engines give the performance this company demands . . . and backs them with outstanding personal service.

NOW NATIONWIDE SERVICE!

If you should ever have a warranty problem with any Airwork overhauled Pratt & Whitney Aircraft engine or its accessories while away from home base, contact the nearest P&WA Authorized Distributor who will take care of you for us.

YOU'RE SAFER WITH AIRWORK OVERHAULED ENGINES

Authorized by Airwork

ALEXANDRIA
ATLANTA NEWARK
MIAMI

Airwork CORPORATION
Millville, New Jersey

The Emblem of Advanced Aircraft Engineering and Proven Performance

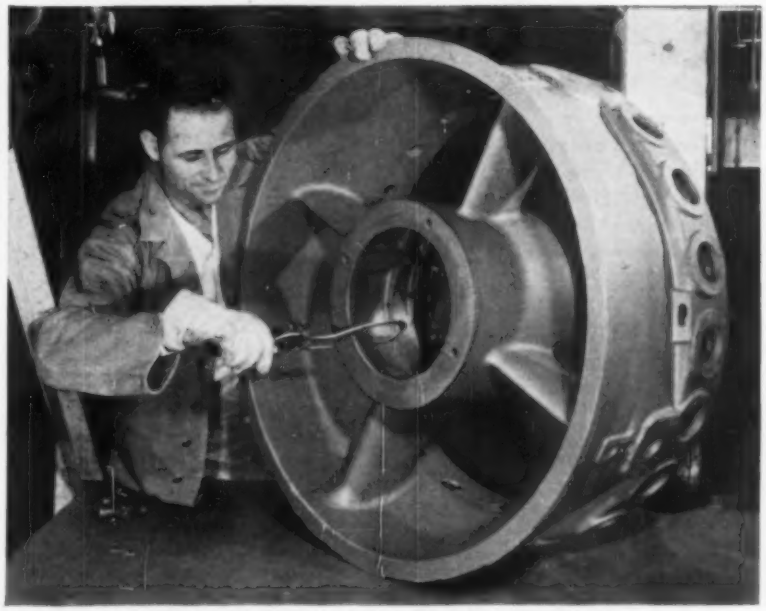
Manufacturers of Hydraulic, Pneumatic, and Electronic Equipment

Gladden

PRODUCTS CORPORATION

635 W. Colorado Blvd., Glendale 4, Calif.

QUALITY MAGNESIUM CASTINGS



A MAGNESIUM SAND CASTING at the Dow foundry. Many kinds of castings are produced—with quality standards to meet the special needs of the aircraft industry.

. . . *for the Aircraft Industry!*

ORDINARY AND EXTRAORDINARY SAND CASTINGS

PERMANENT MOLD CASTINGS

PLASTER CASTINGS

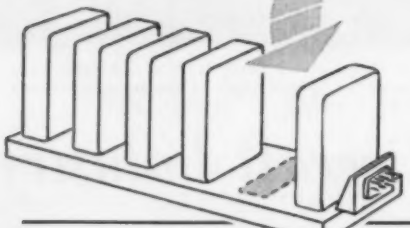
YOU NAME THE CASTING, Dow can supply you with any shape or size required. Specialized inspection techniques rigidly maintain your standards and specifications. Heavy-wall or thin-wall, the best—and surest—answer to your problems are Dow magnesium castings! Contact your nearest Dow sales office for additional information.

THE DOW CHEMICAL COMPANY
Foundry Sales, Bay City, Michigan

DOW

Lightweight! SERVO Magnetic Amplifiers

The servo amplifiers illustrated are typical standard types. Other models, including higher power types, are available for systems engineering. The complete MA line offers the designer a choice of compact, low cost types, amplifiers featuring fast response at high gain and all-magnetic models providing highest performance.



In addition to standard types, custom designs can be produced for special applications, or complete servo and automatic control systems can be engineered to your requirements.

TYPE	SUPPLY	POWER OUTPUT	SENSITIVITY	RESPONSE TIME—SEC.
LIGHTWEIGHT SUB-MINIATURE MAGNETIC AMPLIFIER	115 volts 400 cps.	½, 3, 5, 10 watts	.02 volts	.003
MAGNETIC PRE-AMP + SATURABLE TRANSFORMERS	115 volts 400 cps.	3, 5, 6, 10, 18 watts	1 volt AC	.03
MAGNETIC PRE-AMP + HIGH GAIN MAGNETIC AMPLIFIER	115 volts 400 cps.	5, 10, 15, 20 watts	0.1 volt AC	.008 to .1
TRANSI-MAG*; TRANSISTOR + HIGH GAIN MAGNETIC AMPLIFIER	115 volts 400 or 60 cps.	2, 5, 10, 15, 20 watts	.08 volt AC into 10,000 ohms	.01

Call or write for new illustrated bulletins.

Magnetic Amplifiers • Inc

632 TINTON AVE., NEW YORK 55, N. Y.—CYpress 2-6610

West Coast Division

136 WASHINGTON ST., EL SEGUNDO, CALIF. — EAstgate 2-2056

of TSAGI and was appointed Professor of Hydromechanics at Moscow University. In 1932 he received a concurrent appointment as Professor of Mathematics at the Zhukovskii Military Air Academy, and in 1939 he was given a suitable rank in the Red Army. His simultaneous connection with the Hydromechanics Chair at Moscow University, the TsAGI research staff, and the faculty of the Zhukovskii Military Air Academy illustrates the "multiple hat system"—which kept him in a well-informed and influential position in several activities of the air development program. In 1941 he left the TsAGI staff and was appointed to the University of Sverdlovsk, where part of Moscow University had been evacuated. In 1946 he became Dean of the Mathematics-Mechanics Department of Moscow University and a member of the Mechanics Institute of the Academy of Sciences. He died in 1954.

Judging by the evidence of technical publications, it seems that versatility is also found in the new generation of Soviet fluid dynamicists. In the preface of her book, *Wings of Finite Span in a Compressible Stream*, E. A. Krassilshchikova describes how, in 1942, L. I. Sedov gathered a group of young scientists to form a seminar in supersonic wing theory. The three senior members of the group were F. I. Frankl, an Austrian refugee who had been in the Soviet Union since 1933, who was also leading his own subgroup to brilliant discoveries in transonic flow theory; S. V. Falkovich, who had just obtained his *Doktor Nauk* degree from Saratov University with a thesis on soil seepage and water filtration; and M. D. Haskind, who had published a number of papers on ship oscillation dynamics.

Younger Members

The younger members of the team included A. A. Nikolski, G. I. Taganov, M. I. Gurevich, L. A. Galin, E. A. Karpovich, I. A. Panichkin, and Krassilshchikova. After the completion of their task (and possibly the easing of some wartime security) the group published a series of seventeen papers and two books in 1946-1947. (Coincidentally, this great burst of publications was part of the celebration of the hundredth anniversary of Zhukovskii's birth and of propaganda activities related to the Jubilee of the Academy of Sciences).

Sedov's later career has already been outlined; Frankl's took an abrupt turn. Frankl, an applied mathematician interested in aeronautical problems, was on the faculty of Moscow University and on the research staff of TsAGI from 1933 to 1941. When TsAGI was transferred to Novossibirsk, he became a professor at nearby Tomsk University; after the war TsAGI headquarters was

returned to the Moscow area, and he rejoined the faculty of Moscow University. Since 1952 he has been a professor at the Kirghiz State University, his research bearing on sedimentation in mountain streams and on some questions of the theory of relativity. Why a professor at Moscow University would "compete" for an appointment at the Kirghiz State University was a mystery until a reliable witness stated that the man's loyalty to the regime had been questioned after a friends' arrest.

Hypersonic Flow Problems

Falkovich, after completing his work in soil seepage mechanics, has become involved in hypersonic flow problems (problems of flight at very high altitude and very high speed). Haskind has returned to problems of ship dynamics, on which he has published a dozen papers since 1947. After his stay in Moscow he went to Nikolaev, and he has been at Odessa since 1954. Among the younger group, Nikolski has divided his time between extensions of his wartime work on transonic flow and studies of explosions in coal mines due to high-pressure gas pockets; Taganov has not been heard from; Gurevich has continued to assist Sedov; Galin has applied some of the techniques developed in the Sedov seminar to problems of impact dynamics, seepage and plasticity; Karpovich and Panichkin have not published any work; Krassilshchikova alone is still concerned with supersonic wing theory, of which she has given some interesting extensions. By and large, the Sedov supersonic aerodynamics task force has been dispersed.

The conclusion suggested by the foregoing career summaries is that the education given in the field of theoretical fluid mechanics in the Soviet Union trains young people to take a broad view of basic principles and to apply them in a number of physically unrelated situations. It also appears that it is the conscious policy of the Academy to foster the task-force approach and to stand ready at any time to form task forces of scientists to "launch the struggle" against whatever bottleneck is considered most serious to the over-all research effort. In 1942 Sedov's seminar constituted a task force of that type to attack supersonic flow; other task forces have been launched on the boundary layer problem (1938-1942) and jet-engine design problems (1947-present).

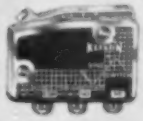
The task-force approach tends to give a spasmodic, scattered appearance to some of the Soviet research; and it emphasizes immediate applications to short-range aims—to the possible detriment of fundamental long-range research. At least one observer (Bock) suggests that as long as research in the West has enough lead to indicate what the significant problems are, the Soviet

Q: What is "COMPLETE COORDINATED PROTECTION" in an aircraft electrical system?

A: It is unrestricted performance of all components in the system under overload, up to individual maximum safe-working capacities of each.

KLIXON C4344 Hermetically Sealed Thermostat

KLIXON KX-4 Hermetically Sealed Precision Switch



KLIXON 3-Phase Inherent Overheat Aircraft Motor Protector

KLIXON D6760 3-Phase Circuit Breaker

With the successful development of the new KLIXON 3-Phase Inherent Overload Protector, Spencer Thermostat Division can now supply Complete Coordinated Protection for aircraft electrical systems.

The new protector is designed for application to 3-phase, 400 cycle, aircraft electric motors — just as its single phase predecessors have been applied so effectively over the years to single phase and D.C. aircraft motors.

With proven single and 3-phase KLIXON Aircraft Circuit Breakers for conductor protection, plus KLIXON high altitude hermetically sealed thermostats and precision switches, this new protector rounds out the KLIXON aircraft products line to make "Complete Coordinated Protection" possible in aircraft electrical systems.

Write attention of Product Manager for full details.

Another new control by

KLIXON®

METALS & CONTROLS CORPORATION
SPENCER THERMOSTAT DIVISION
2809 FOREST STREET, ATTLEBORO, MASS.

Radiation effects being studied in special laboratory

The flight date of the first atom-powered airplane may well be advanced as the result of a study being conducted by Admiral for the U.S. Air Force. The problem is to determine the effects of nuclear radiation on electronic components.

All types of electronic components . . . such as tubes, resistors, condensers, capacitors and coils . . . are first bombarded by neutrons to make them radioactive prior to observation and testing.

Admiral has equipped a special nucleonics laboratory to make this study. Test equipment is set up within heavily shielded "hot cells" and operated by remote controls outside each room. One of the "hot cells" contains environmental chambers for testing the radioactive components under extreme temperature and altitude conditions. The laboratory also contains shielded underground storage facilities and a cobalt 60 source of gamma radiation as powerful as some atomic reactors.

Working with radioactive materials is not new to Admiral. For the past seven years the company has been engaged in designing, manufacturing and testing radiation measurement equipment. In this connection Admiral engineers have contributed much to the combined nucleonic-electronic sciences.

Admiral.
CORPORATION

Government Laboratories Division, Chicago 47

LOOK TO *Admiral* FOR
RESEARCH • DEVELOPMENT • PRODUCTION
IN THE FIELDS OF:

COMMUNICATIONS UHF AND VHF • MILITARY TELEVISION
RADAR • RADAR BEACONS AND IFF • RADIAC
TELEMETERING • DISTANCE MEASURING
MISSILE GUIDANCE • CODERS AND DECODERS
CONSTANT DELAY LINES • TEST EQUIPMENT

Facilities Brochure describing Admiral plants, equipment and experience sent on request.

ENGINEERS: The wide scope of work in progress at Admiral creates challenging opportunities in the field of your choice. Write Director of Engineering and Research, Admiral Corporation, Chicago 47, Illinois.

task forces will be able to solve those problems as rapidly and effectively as Western groups; but he questions the ability of the Soviet research apparatus to uncover and formulate new problems. Soviet performance in developing transonic aerodynamics ahead of the United States and linear supersonic aerodynamics independently of the United States suggests that such a view may not be justified.

In any case, the availability of high-quality versatile research personnel and the application of their skill to whatever practical problem is most pressing indicate an efficient and, for the present, generally successful planned use of scientific manpower by means of what has been called above the "multiple hat system."

As a consultant to the design team, the senior scientist becomes familiar with the problem; as a member of an Academy committee, he agitates for the formation of a research group; as a professor senior laboratory staff member, he is in a position to help recruit and direct a research group generally assembled under his chair. And the younger man learns the facts of the relationship between research and production and broadens his experience by taking part in the work of the task force until he becomes mature enough to lead one.

This Soviet method of managing scientific manpower, which stresses versatility in application, is particularly suited to theoretical investigations. It is much easier to adapt a mathematical formula to fit a new physical problem than to develop an experimental technique. There is evidence that in the field of fluid mechanics much greater reliance is placed on theoretical research in the Soviet Union than in most Western countries because it is easier and less expensive to develop the required staff and equipment and because, apparently, this approach is traditionally much more congenial to the Russian scientist.

Soviet progress in theoretical fluid mechanics is generally impressive. Soviet scientists have contributed their full share of new ideas, and they are abreast of their counterparts in any other country. On the other hand, examination of textbooks and published papers on experimental research indicates that, while the techniques developed in Germany, Britain, and the United States up to 1952 are known to the Soviet scientists, they have not sought new techniques and have used the imported techniques more for routine testing than to attempt to break new ground by means of fundamental experimental research.

The task-force system infringes on the local independence of universities and

Parachuting Behind the Iron Curtain

Scenes at Third World Parachute Championships witnessed by some 100,000 Muscovites at Tushino Airport recently. Czech parachutist (top left) pulls ripcord with right hand immediately after leaving An-2 Colt transport used for jumps. Note pilot chute already starting to fill, jump targets below, city of Moscow across river in background. Americans (bottom left) poised for jump from An-2. Jack Andre Istel of Air Associates, Teterboro Airport, is standing in aisle. Several practice jumps were made to familiarize contestants with speed, characteristics of aircraft. Soviets' Ivan Fedchishin (right) ascending to take first place in men's 1,500 meters jump with free fall of 20 seconds. Note open panel, steerable chute. Soviet team won meet.

UNFAILINGLY, Carma push button warning lamps keep constant watch over as many as 90 operating units in late model aircraft. Any deviation from normal functioning is automatically flashed in front of the pilot — and stays as a reminder until the condition is corrected. No lettering is visible during normal operation. Carma warning lamps are mechanically keyed to insure correct assembly. Extremely compact; each unit weighs only ⅝ oz.

OTHER Carma PRECISION PRODUCTS

TRIM TAB ACTUATORS
SOLENOID OPERATED VALVES
FUEL CONTROL VALVES
TEMPERATURE CONTROLLER
REEFING RELEASES
LIGHTED LANDING GEAR SWITCHES
PULSE CONTROL GENERATOR
HYDRAULIC PUMP CONTROL
SPEED SWITCHES
CANOPY SEAL PRESSURE REGULATORS

As an approved supplier to prime contractors engaged in the production of classified material, Carma is staffed and equipped to step in at any stage of product development and perform capably as an integral part of the production team.

Carma
MANUFACTURING
Company

TORRANCE, CALIF.
1879 MULLIN AVE.

TUCSON, ARIZ.
3544 E. FORT LOWELL

CARMA MANUFACTURING CO. AW-956
1879 Mullin Ave., Torrance, Calif.

Please send us without obligation, complete catalog of Carma aircraft equipment and controls, with drawings and specifications.

NAME_____
FIRM_____
DEPT_____
ADDRESS_____
CITY_____ STATE_____

interferes with their continuing long-range research plans by drawing on their staffs at unpredictable times. It also disturbs the younger scientist's personal life and limits his opportunity to select the problems which interest him most. It may discourage his initiative since it puts the ultimate responsibility on relatively small committees of senior scientists who must correctly predict which problems will be of greatest practical importance in the years ahead and how those problems are best attacked.

Graduate Training

Graduate training, leading normally in three years to the first academic degree (*kandidat nauk*), introduces the advanced student to research in his area of specialization. Those selected for graduate work (*aspirantura*) are called *aspiranty*. An aspirant spends some part of his time taking advanced courses and keeping his ideology up-to-date, but the greater part of his effort is devoted to research in the laboratories of an institution which has graduate training programs. If his research thesis (defended before an examining committee appointed by the Ministry of Higher Education) is satisfactory, the aspirant receives the *kandidat nauk* degree. On the basis of age, length of time spent in school, and the content of theses, the qualifications of a *kandidat nauk* appear to be similar to those of a Ph.D. in this country.

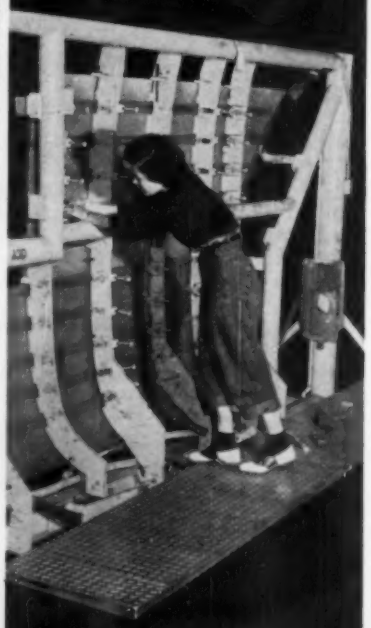
Graduate training at the aeronautical institutes is offered in many fields, corresponding usually to the areas of research most strongly developed in a given school. In 1954 the two aeronautical institutes in Moscow, where some 250 aspirants are trained and some 30 become *kandidaty nauk* each year, announced graduate courses in the following fields:

Ordzhonikidze Air Institute:
- **Strength of materials.**
- **Machine design.**
- **Theory of mechanisms.**
- **Machine tools and cutting tools.**
- **Plant safety techniques.**
- **Design of electrical machinery.**
- **Physics and metallurgy.**
- **Descriptive geometry and drafting.**
- **Advanced mathematics.**

Air Technology:
- **Metallography** and heat treatment of nonferrous alloys.
- **Technology of foundry production.**
- **Technology of machining metals.**
- **Technology of instrument** manufacture.
- **Strength of materials.**
- **Technology of welding production.**

The regulations for the awarding of the degree *Kandidat nauk* are strict. The candidate must pass a number of examinations on his course work and defend a thesis before a State Examining Commission. There is in addition a

A tooling problem?



INVESTIGATE
RED METALS CO. SEAL

ALUMINUM TOOLING PLATE ALLOY 2424-C

Alloy 2424-C is Red Seal's new designation for their aluminum tooling plate and bar stock. The new designation is to help you better understand material composition. The "C" indicates material is cast.

Investigate

the advantages of low cost Red Seal Plates and Bars for your tooling requirements.

Call or write for this new Red Seal Aluminum Products Catalog.

Eastern Distributor:
Aluminum Division of
Atlantic Steel and Iron Co.
Page Boulevard, Springfield, Mass.
Phone: REpublic 9-9611

RED SEAL METALS CO.
10035 Burtis Street
South Gate, Calif., LOrain 6-5105

three-year time limit to *aspirantura* (four years for correspondence students) which was apparently imposed because too many aspirants, particularly at universities, preferred the relatively sheltered if austere life of a student and, consequently, showed no eagerness to complete their theses.

It would appear from recent complaints in Soviet literature (*Vysshaya Shkola*, August 1955) that the time-limit rule has not succeeded in increasing the number of completed theses but rather has made it possible to eliminate the "eternal students" and so make more of the professorial time available to those who devote themselves to their work. Apparently, only between one-half and one-third of the aspirants ever complete their theses successfully, and of these only a fraction ever publish another paper.

If a *kandidat nauk* pursues an academic career, after from five to ten years and after publication of an important piece of research he may become a *doktor nauk*, eligible to compete for an appointment as a professor. The Soviet *doktor nauk* degree may be likened to a British Sc.D. or the German *habilitation*.

Research Institutes

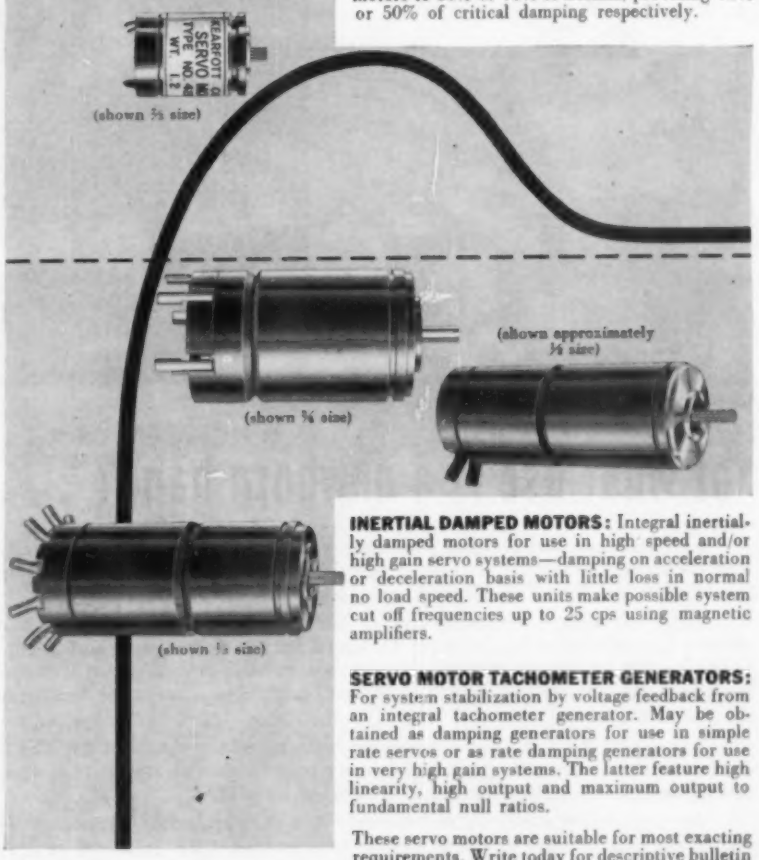
It is important to note here that graduate training programs are maintained not only in a number of regular institutions of higher learning (universities, polytechnic, and specialized technical schools, e.g., aeronautical institutes and air academies) but also in a large number of research institutes maintained by the various ministries and by the academies of science.

Thus, of the 216 institutions authorized—subject to normal certification by the Ministry of Higher Education—to grant Doctor of Science (*doktor nauk*) degrees, 72 (or one-third) are not colleges or universities but industrial or Academy of Science research institutes. Since most of the 72 Academy and other research institutes and military schools are located in the Moscow or Leningrad area, the concentration of advanced training and research in Moscow and Leningrad is considerable, acting as a magnet on the brighter young scholars and tending to increase that concentration in spite of efforts by the government to reduce it.

The number of graduate students at Soviet technical schools is uniformly low, ranging from 2.0% of the student body at Bauman Technical School down to zero as compared to 40% at Caltech, 38% at MIT, and an average of 12% in American Technical schools. The Soviet situation may be the result of a deliberate policy which aims to get engineers into the industrial stream as quickly as possible and to enable the senior professors to educate the best

There is no one "cure all" for system instability. The desired stability of a servo loop is attained through the proper selection of components that satisfy the various conditions under which the loop will operate. Kearfott offers four basic motors and combinations for providing system stability. All feature high speed of response; low inertia and high stall torque.

SYSTEM STABILITY



SERVO MOTORS: Servo motors with high torque to inertia characteristics possessing (built-in) inherent damping ranging in size from ¾" to 1¾" diameter are available. Low speed, low power motors for use in simple instrument servos where high damping and/or low time constant is required can also be provided.

VISCOUS DAMPED SERVO MOTORS: Provide integral viscous damping for simple instrument servos. Any degree of damping can be provided. These units reduce no load speed of standard motors to 50% or 75% of normal, providing 70% or 50% of critical damping respectively.

INERTIAL DAMPED MOTORS: Integral inertially damped motors for use in high speed and/or high gain servo systems—damping on acceleration or deceleration basis with little loss in normal no load speed. These units make possible system cut off frequencies up to 25 cps using magnetic amplifiers.

SERVO MOTOR TACHOMETER GENERATORS: For system stabilization by voltage feedback from an integral tachometer generator. May be obtained as damping generators for use in simple rate servos or as rate damping generators for use in very high gain systems. The latter feature high linearity, high output and maximum output to fundamental null ratios.

These servo motors are suitable for most exacting requirements. Write today for descriptive bulletin giving data of components of interest to you.

KEARFOTT COMPONENTS INCLUDE:

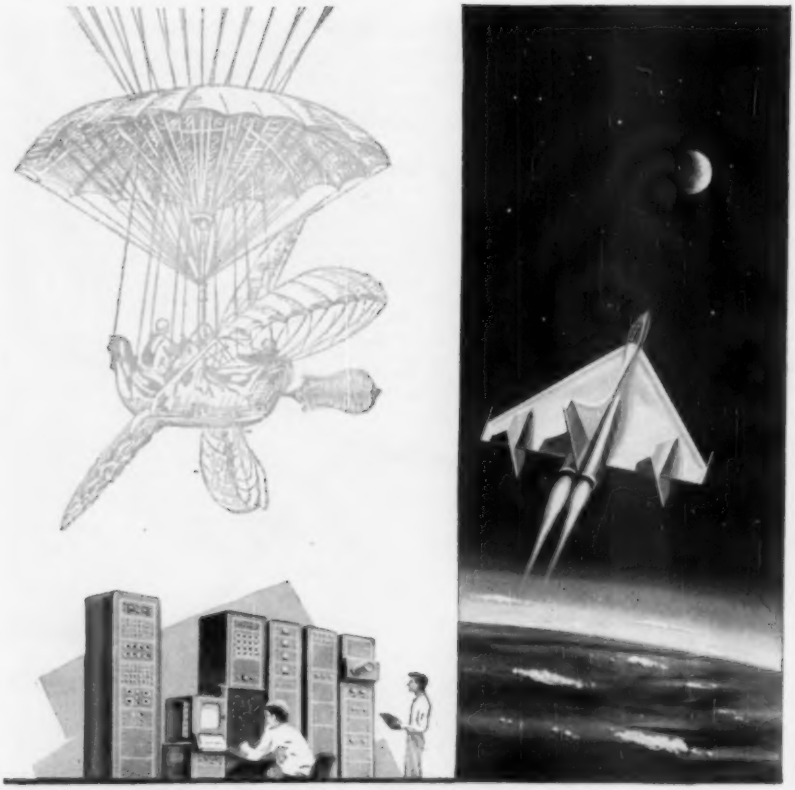
Gyros, Servo Motors, Synchros, Servo and Magnetic Amplifiers, Tachometer Generators, Hermetic Rotary Seals, Aircraft Navigational Systems, and other high accuracy mechanical, electrical and electronic components.

Kearfott

A SUBSIDIARY OF GPE

KEARFOTT COMPANY, INC., LITTLE FALLS, N. J.

Sales and Engineering Offices: 1378 Main Avenue, Clifton, N. J.
Midwest Office: 188 W. Randolph Street, Chicago, Ill. South Central Office: 6115 Denton Drive, Dallas, Texas
West Coast Office: 253 N. Vinedo Avenue, Pasadena, Calif.



ONE OF A SERIES — depicting Aerodynamics — "Yesterday, Today & Tomorrow"

"of what use is a newborn babe?". . .

Such was Benjamin Franklin's comment after watching successful experiments with hot-air balloons in 1783. In the same year, M. de Rozier made man's first flight in a *Montgolfières* before the King's Court at Versailles.

Early ballooning contributed little to the science of aerodynamics, but it did create a tremendous interest in flying. Lacking a suitable power plant, such methods as rowing through the air with silk-covered oars, or hand propelled fans were tried. Because of this lack, ballooning had to depend upon the vagaries of the weather and the skill of the aeronaut.

Today, Bell Aircraft's top engineering teams have long discarded the trial and error methods of early experimenters. Now, the entire flight characteristics of a plane or a guided missile can be determined by banks of simulators.

An engineering career at Bell Aircraft is a rich, rewarding experience with one of the world's most advanced aircraft corporations. Creative ability is a vital asset to professional advancement. Bell's long list of projects is always increasing as a result of the constant flow of new ideas and discoveries.

For work on configuration, performance, stability, maneuverability, propulsion pressure distribution, and thermal characteristics, Bell Aircraft has openings for —

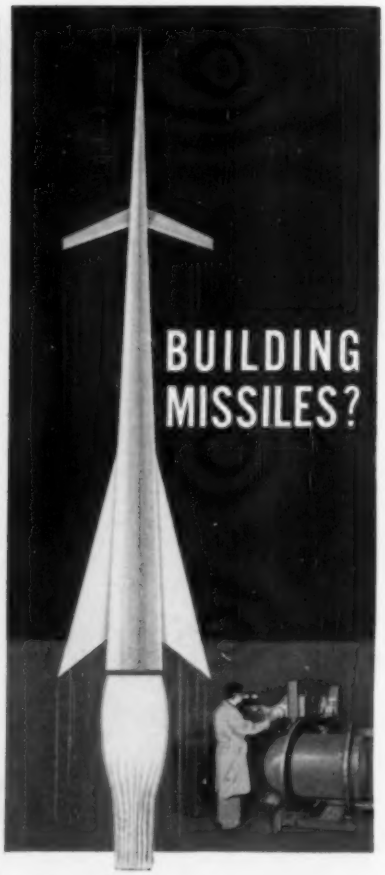
ENGINEERS, PHYSICISTS, and MATHEMATICIANS, with backgrounds in:

- **Aerodynamics**
- **Heat Transfer**
- **Propulsion**

Please contact . . .
Manager, Engineering Personnel

BELL *Aircraft* CORPORATION

P. O. Box 1 Buffalo 5, N. Y.



RESEARCH WELDING

for fabrication beyond the standard concept

For fabrication of guided missile components and atomic structures and for other technical projects, Research Welding is equipped to process experimental work requiring high-strength or corrosion-resistant alloys.

Our facilities include a 650-ton capacity HPM metal forming hydro press and the latest automated welding equipment. Mass Spectrometer and hydro testing; USAF-approved quality control procedures.

Research Welding has developed components for CalTech, Douglas, DuPont, Firestone, GE, Hughes, Bell, Northrop, USAF.

Let us analyze your problem. Call or write today for information. New, ultra-modern plant now under construction will provide even greater facilities for the scientific development of your special projects.

RESEARCH
WELDING & ENGINEERING CO., INC.

10608 SANTA FE AVE. • SOUTH GATE, CALIFORNIA

graduate as carefully and thoroughly as passible; for, because of the somewhat mechanical nature of the average engineering education, the leaders carry a heavy responsibility both as teachers and as senior research staff members.

The difficulties encountered in training enough graduate students to a sufficient peak of perfection are the subject of much concern at present in educational circles of the Soviet Union and, apparently, justly so, since the shortage of competent teachers is a major bottleneck in the expansion of the educational system.

Aircraft R & D

Aircraft research and development are concentrated largely at the specialized research institutes—such as the Central Aero- and Hydrodynamic Institute (TsAGI) and other institutes of the Aircraft Production Ministry. But research done by the faculty members and graduate students at the polytechnic institutes and at the military academies (such as Zhukovskii Air Academy in Moscow) is also a very important factor in the growth and development of Soviet competency in aeronautics. In a number of fields research task forces using the facilities and the leadership provided by polytechnic institutes, for instance, have contributed important results in the development of specific pieces of equipment or in the solution of specific technical problems in the field of aeronautics. To illustrate this activity, one may consider the work of L. G. Loitsianski, Professor of Mechanics at the Leningrad Polytechnic Institute.

Mechanism of Drag

L. G. Loitsianski is of the same generation and academic background as L. I. Sedov of Moscow University.

During the 1930s Loitsianski was associated with TsAGI, taking a leading part in their studies of the mechanism of air resistance or drag. A German aerodynamicist, L. Prandtl, suggested in 1904 that a major portion of that drag is due to the viscous friction of the air in a very narrow layer near the solid surfaces along which it flows (boundary layer).

The practical importance of Prandtl's idea was just being generally appreciated about 1925 (possibly somewhat later in the Soviet Union); and it became Loitsianski's task, first at TsAGI and after 1935 at the Leningrad Polytechnic Institute, to develop practical methods of calculating the flow in the boundary layer. Between 1941 and 1943 Loitsianski and a group of students published a dozen papers to outline their solution of the problem, which is an extension of a method proposed by Th. von Kármàn in Germany in 1921.

Loitsianski's method has the advantage of being applicable to a wide variety of problems and of being quite straightforward and reasonably accurate. It is therefore well adapted to engineering calculations and appears to be in general use in the Soviet Union, but it is unwieldy and not suited to the investigation of the effect of viscous forces on high-speed modern aircraft. This is not because Loitsianski is incapable of more elaborate or fundamental analysis. His publications on turbulence and his textbooks show that he has the solid mathematical education expected of a Russian scientist; but his boundary layer theory was meant to be, and within its range of application is, an engineering tool within reach of the average designer.

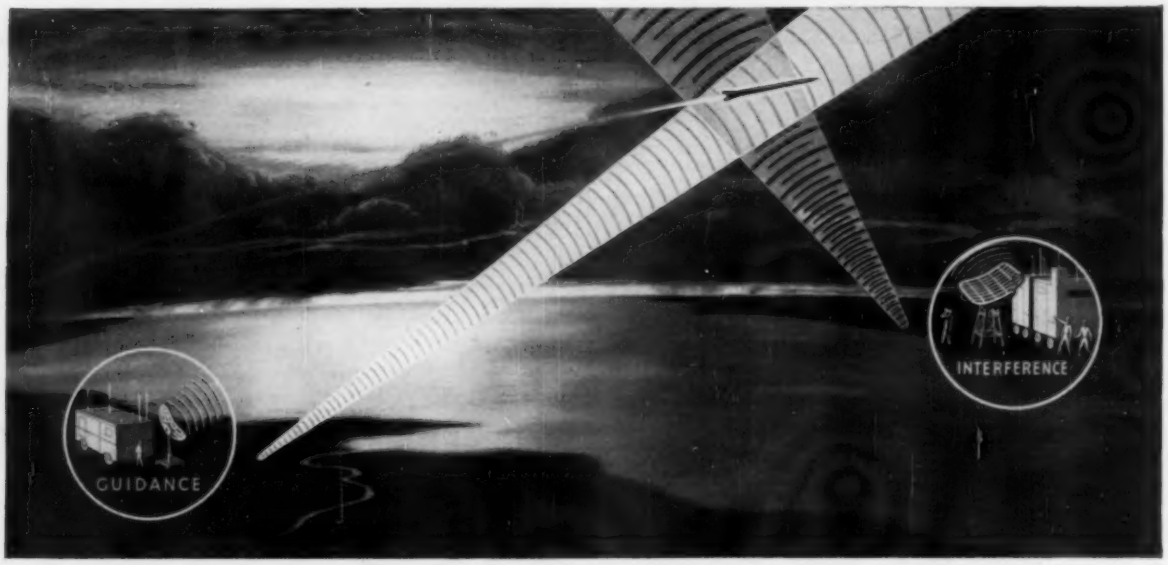
Since the war Loitsianski and a large group of assistants have undertaken a program of basic studies of the gas flow in turbines. This problem is far too complicated for a rational solution. A good deal of engineering sense and experimentation are required to bring out its essential features and to create an ideal model simple enough to permit analysis and realistic enough to serve as a basis for engineering estimates. Recent press releases have indicated that the Soviet aircraft industry has produced turbojet engines appreciably more powerful than those in mass pro-

TEAMWORK
Whittaker gyros are designed and built by a staff of engineers and technicians that has remained practically intact for more than a decade.
By working together, they have been able to produce gyros that are unsurpassed for strength, accuracy and reliability. The proof is in Whittaker's overall customer rejection of less than 2%.
Whittaker Gyro
DIVISION OF TELECOMPUTING CORPORATION
VAN NUYS, CALIFORNIA
STANLEY 7-5511

Notable Achievements at JPL

***SECURE COMMUNICATIONS SYSTEMS...JPL** scientists and engineers have made outstanding contributions to the research and development of communications systems designed to operate in the presence of severe interference.*

Protection of a communication system from deterioration by extraneous interference is of paramount importance to the ultimate utility of that system. At the Jet Propulsion Laboratory this pressing practical challenge has been met with concrete achievement in basic and applied communications research, paired with sound development engineering.



Pioneers in Guided Missiles

JPL JOB OPPORTUNITIES ARE WAITING FOR YOU TODAY
in these fields

- RADIO GUIDANCE
- MICROWAVES
- ELECTRONIC RESEARCH
- SYSTEMS ANALYSIS
- GUIDANCE ANALYSIS
- ELECTRO MECHANICAL
- INSTRUMENTATION
- INERTIAL GUIDANCE
- TELEMETERING
- PACKAGING
- MECHANICAL ENGINEERING

The Jet Propulsion Laboratory is an organization devoted to scientific research and development. Its prime objective is obtaining basic information in the various sciences related to missile systems development, including all phases of jet propulsion. The Laboratory maintains as its basic foundation, a major uninterrupted program of fundamental research in most of the physical sciences.

The Laboratory occupies an 80-acre plot in an otherwise residential area in the San Gabriel mountain foothills North of Pasadena. Its staff of approximately 1,250 persons are all employed by the California Institute of Technology, and it conducts its several projects under continuing contracts with the U.S. Government.

In its missile system and jet propulsion undertakings, the Laboratory maintains a broad technical responsibility, from basic research to prototype engineering. By virtue of the Laboratory's broad area of responsibility and the integrated nature of the JPL technical staff an individual scientist or engineer is brought into satisfyingly close contact with the general field to which his technical speciality contributes.

If you are interested in knowing more about the Jet Propulsion Laboratory and its specific employment offerings, please write.

CALTECH jpl **JET PROPULSION LABORATORY**

A DIVISION OF CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

duction in the United States at the present time.

While know-how and ideas from German and other sources have helped in this Soviet accomplishment, they would not have been absorbed and put to effective use so rapidly if native groups such as Loitsianski's had not mastered the fundamentals of the problem independently and prepared a sufficient number of engineers to extend and improve good borrowed ideas in an original and skillful manner.

In connection with such work it is essential to check experimentally the results predicted from various simplifying assumptions, since these are suggested by engineering intuition and must be discarded unless they give reliable estimates. And, indeed, some competent instrumentation has been developed and used in connection with Loitsianski's work, especially the later work on turbines.

Although the Soviets are generally close-mouthed about their aeronautical testing equipment, they have recently described some optical apparatus and some fast-acting pressure pickups which indicate an ability to perform accurate measurements under difficult physical conditions.

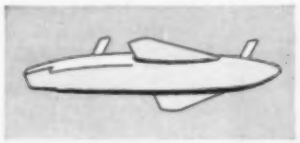
The inevitable reliance on experiment makes it difficult to organize engineering development task forces similar to the theoretical groups described previously. The Soviet development engineer is more closely linked with his equipment and his versatility, while surprisingly great in a few leaders like Loitsianski, cannot be compared with that of an applied mathematician. Nevertheless, the research personnel at Soviet polytechnic institutes who contribute to the study of basic engineering concepts underlying aircraft propulsion are doing their jobs with imagination, competence, and apparent success.

Flow Techniques

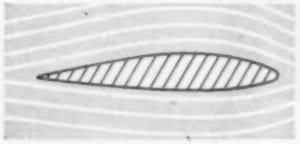
An indication of the quality of the research done at the Zhukovskii Academy is given by a recent booklet published by A. N. Zaks on flow visualization techniques (1950) which describes the quality and type of equipment available there for experiments in aerodynamics. Zaks, who graduated from the Academy in the late 1940's, discusses some of the wind tunnels and optical instruments available at the Academy and shows photographs of simple tests carried out there.

Facilities in which speeds up to twice the speed of sound are reached were evidently in operation in the late forties, and adequate instrumentation was also in use. The Zaks booklet and other stray references in the Soviet literature suggest that the experimental equipment available at the Academy is kept fully up-to-date and as good as

Yes even ice- and snow-covered areas can be utilized as landing fields for aircraft designed to include the Pantobase landing system. A product of Stroukoff research and development, Pantobase will permit landings and take-offs from snow, ice, sand, water and unimproved terrain, thereby extending the operational capabilities of the aircraft and reducing the need for conventional airports in many remote and previously inaccessible parts of the earth's surface.



Pantobase—When designed into an aircraft the Pantobase system enables the plane to land and take-off from many types of surface without changes of additional landing equipment.



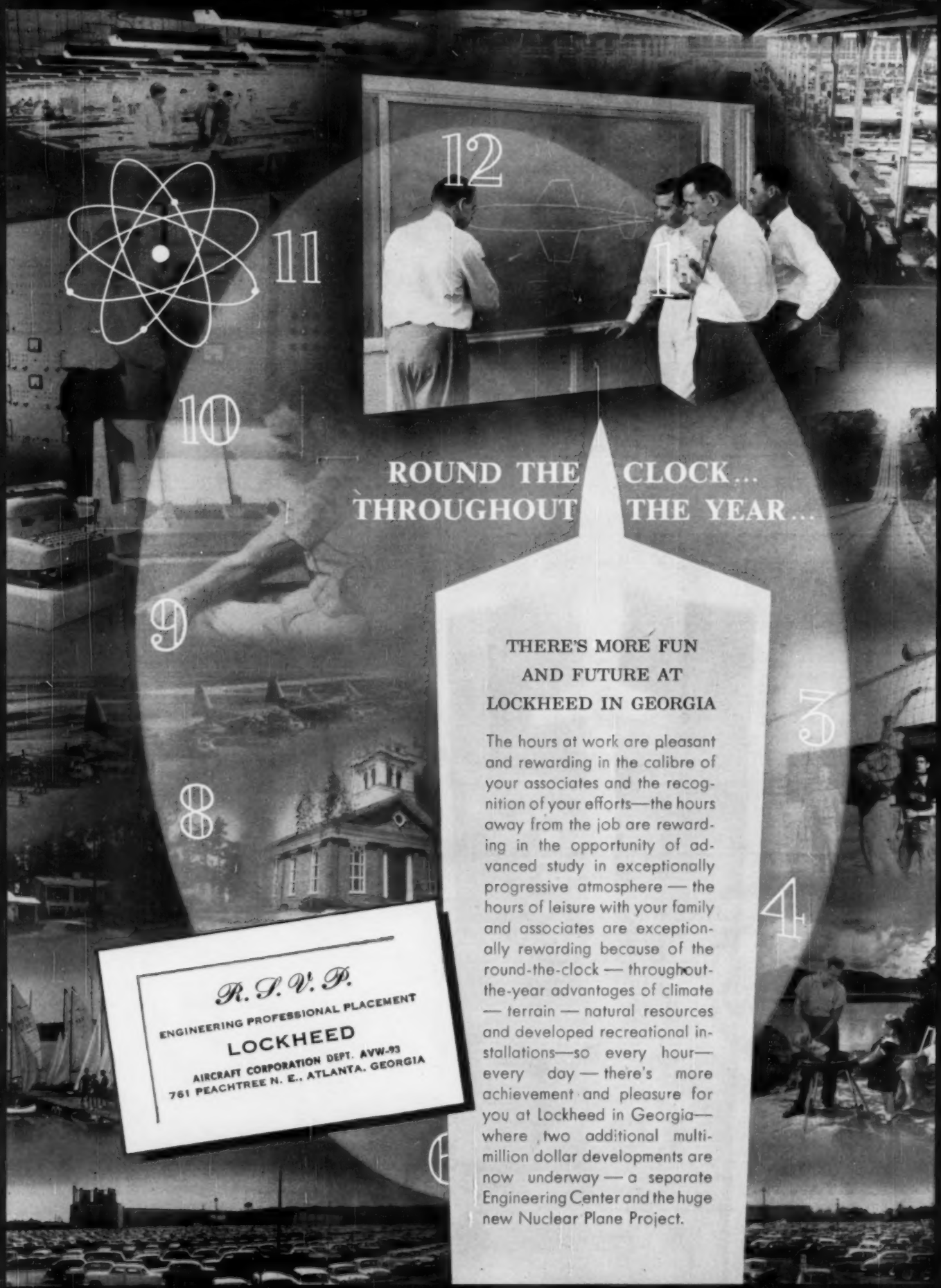
BLC-Boundary layer control as developed by Stroukoff increases the effective lift and delays stalling of the wing, thereby reducing required speeds and djstances for take-offs and landings.

Achievement is a tradition at Stroukoff. A leader in the development and design of cargo and transport aircraft, Stroukoff offers challenging opportunities to creative engineers.

Extending the Frontiers STROUKOFF AVITRUC *of Aircraft Performance*

Stroukoff

WEST TRENTON, NEW JERSEY


12
11
10
9
8
3
4
ROUND THE CLOCK...
THROUGHOUT THE YEAR...
THERE'S MORE FUN
AND FUTURE AT
LOCKHEED IN GEORGIA
The hours at work are pleasant and rewarding in the calibre of your associates and the recognition of your efforts—the hours away from the job are rewarding in the opportunity of advanced study in exceptionally progressive atmosphere — the hours of leisure with your family and associates are exceptionally rewarding because of the round-the-clock — throughout-the-year advantages of climate — terrain — natural resources and developed recreational installations—so every hour—every day — there's more achievement and pleasure for you at Lockheed in Georgia—where two additional multi-million dollar developments are now underway — a separate Engineering Center and the huge new Nuclear Plane Project.
R. S. V. P.
ENGINEERING PROFESSIONAL PLACEMENT
LOCKHEED
AIRCRAFT CORPORATION DEPT. AVW-93
761 PEACHTREE N. E., ATLANTA, GEORGIA

Soviet technology can make it.

The work load, strain of frequent examinations, and unusually severe political supervision apparently take such a heavy toll of the students that only about a quarter of admitted cadets graduate. In one case where firsthand information is available, only six out of a section of twenty-two finished the course. Soviet wastage here appears higher than the average graduate school wastage. Since the cadets hold a commission in the Red Air Force, failure means assignment to a military post in the field.

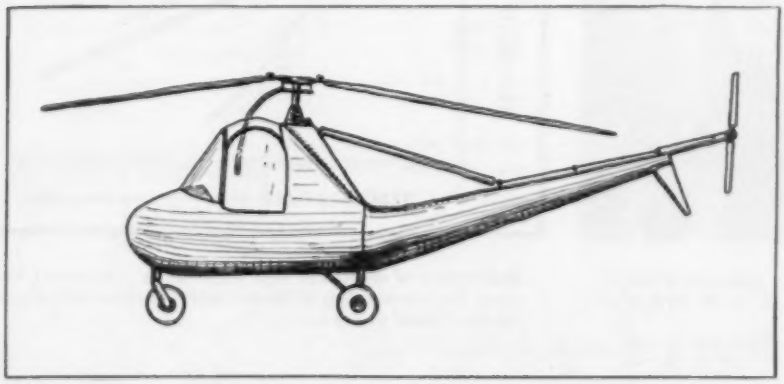
Those students who graduate assume positions of responsibility in the technical planning of the Air Force. In at least two instances, sufficient technical publications are available to form an objective opinion of the ability and training received at an air engineering academy.

Professor A. P. Melnikov received his degree of Doctor of Technical Sciences from the Leningrad Air Engineering Academy (in 1942) with a thesis presumably done under Professor Loitsianski in which he works out an original application of Loitsianski's boundary laye: method to the problem of designing a wing of reduced air resistance. He has apparently continued this work and presented new significant results at the Third All Union Applied Mathematics Congress in 1953. He is evidently a competent applied scientist with good engineering sense.

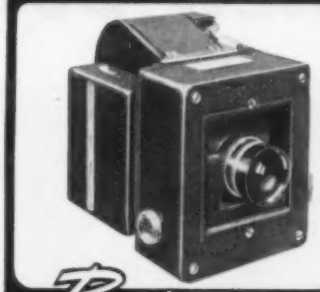
Shortly after his graduation from the Zhukovskii Academy in 1952, A. N. Zaks published a textbood on *Applied Aerodynamics* which displays a thorough knowledge of developments in his field, both in the Soviet Union and abroad, and the ability to organize his material clearly and to emphasize the points likely to be significant in the future; on the basis of that book, one may also consider him a thoroughly qualified aeronautical engineer.

Drawing Forecast Czech Helicopter

From a photograph of only the tail rotor of a new Czech helicopter, Eugene K. Liberatore, a helicopter expert, was able to make a drawing for Aviation Week of the entire machine (AW April 23, p. 65). How close he came is readily apparent from the photograph of the same machine provided by Ralph W. Kummer, public relations manager of Hiller Helicopters, after he saw the drawing. A Czech interested in VTO sent Kummer the picture. The helicopter, designed by a group under Jaroslav Slechta at the Research Institute of Aviation, is derived from the Slechta XE-11. Powerplant of the two-seater is a Praga G four cylinder engine rated at 80 hp. Gross weight is 1,234 lb. Top speed of 75 mph., rate of climb 200 fpm. and ceiling of 10,164 is claimed. Liberatore correctly projected the overhanging stick control, three-blade single rotor, the general landing gear form and entire configuration.



Designed for Aircraft, Industrial and Scientific Instrumentation



Beattie VARITRON
Electric Camera - Model D

- Radar Scope recording
- Oscilloscope recording
- Panel instrumentation
- Aerial spotting
- Security surveillance
- Personnel survey
- Identification
- Manometer panel recording
- Test surveillance
- Inspection records

Here is the versatile data recording camera that saves you time and labor, and gives you a permanent, accurate record. Rugged construction . . . interchangeable lenses . . . available in different camera body lengths for special applications.

Write for complete detailed literature today.

Photographic Products Inc.

1000 North Olive St. - Anaheim, California

Single source facilities for:
Low temperature
High temperature
Environmental vibration
High altitude
Sand & dust
Humidity
Salt spray
Shock
Accelerated corrosion
Rain
Sunshine
Immersion
Radio interference
Noise level
Acceleration
Endurance
Explosion
Fungus
Fuel resistance
Hydraulic flow & pressure
Contaminated fuel

TOO LATE FOR TESTING NOW...

...time for testing your military aircraft and missile equipment starts long before first flight, back around the time of prototype models — and that's the time to call the Test Engineer from AEROTEST.

AEROTEST has the technical staff, modern facilities, and aircraft experience to satisfy *all* your testing needs.

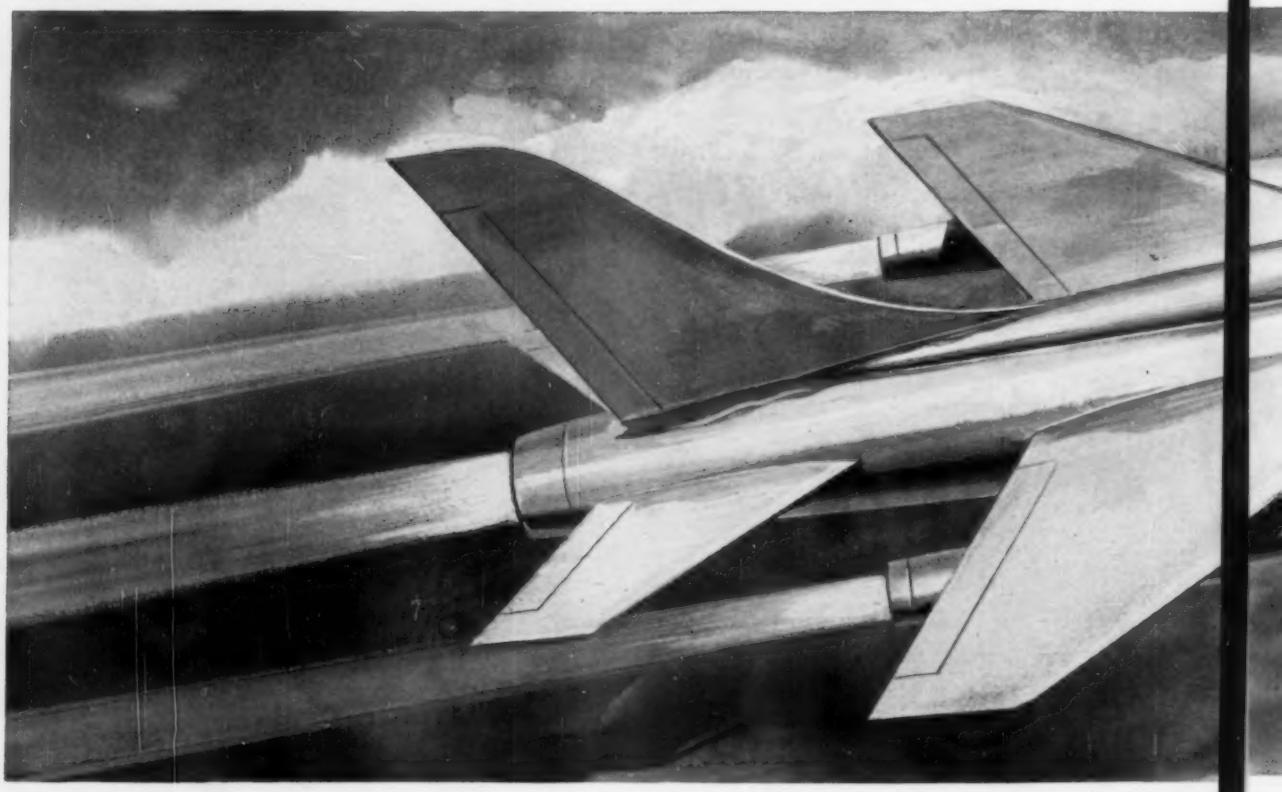
- Design tests
- Qualification tests
- Sampling tests
- Design recommendations
- Quality control systems
- Special test equipment

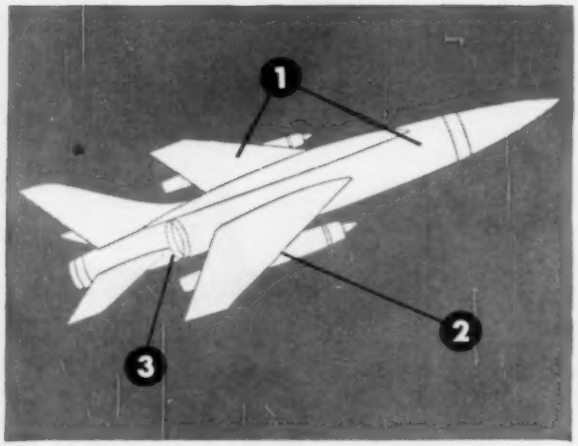
Proposals submitted without obligation

Aerotest LABORATORIES, INC.

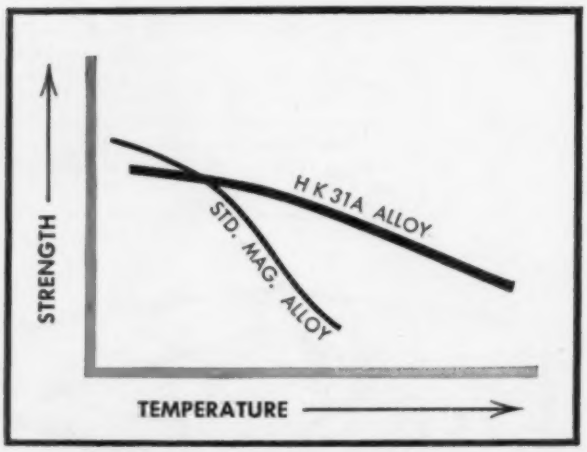
Free! Attractive wall chart of useful handbook data. Conversion factors, tables, etc. A real time-saver. For free copy, write: AEROTEST, DEPT. A1
15-35 129TH ST., COLLEGE PT., N.Y.

NEW DOW MAGNESIUM ALLOYS





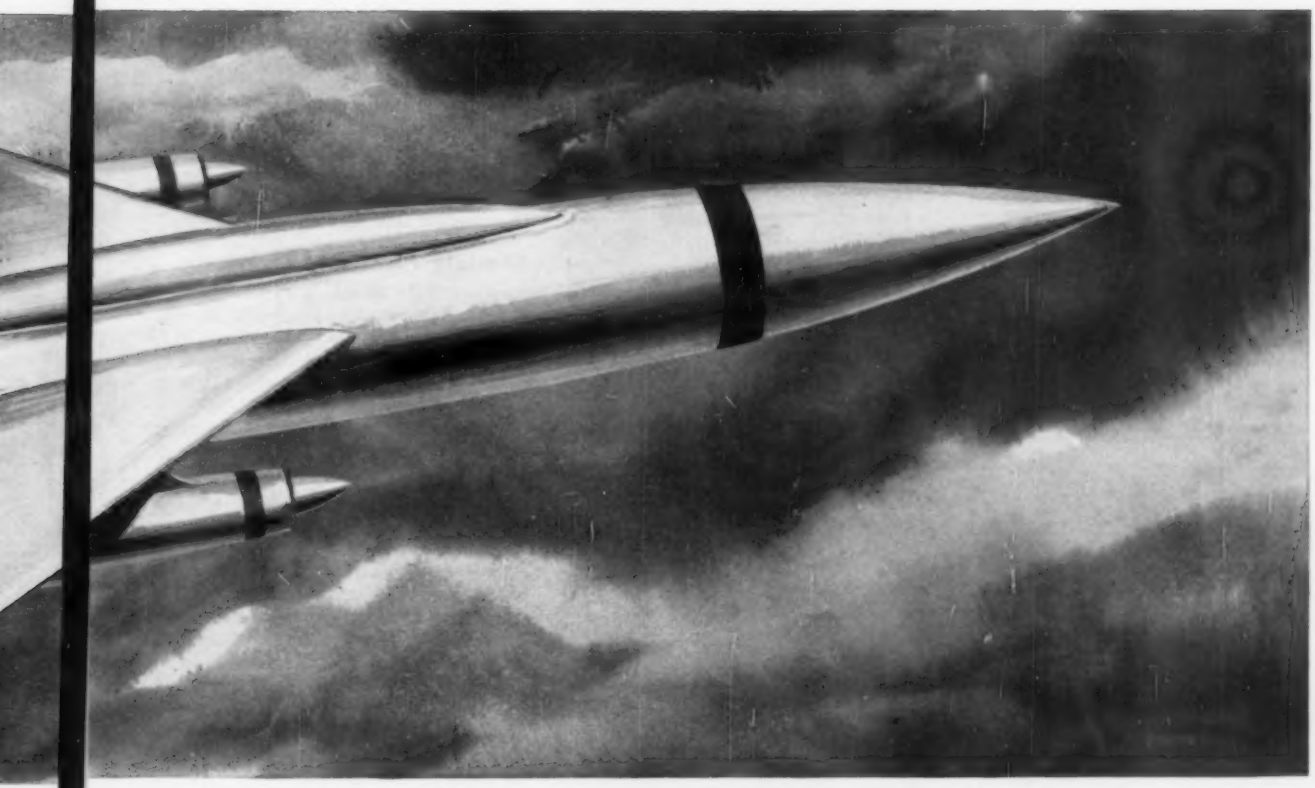
Now suggested *for a broad range of uses in missiles and aircraft, the new Dow magnesium alloys are available in the form of (1) sheet or plate, (2) extrusions, (3) castings.*



Maintenance of strength *at high temperatures is illustrated by this chart. Performance data on the new alloys at elevated temperatures can be obtained by request.*

DOW

CRACK HEAT BARRIER!



High temperature magnesium alloys are available to lighten aircraft and missile structures

Once again the horizons for aircraft structural design have been widened. Dow has developed a series of high temperature magnesium alloys which are already in pre-production use on aircraft, missile and engine structures. These alloys show advantages at temperatures up to 700° F. Limited test data on properties up to 800° F. are available for some of these alloys.

The new alloys save precious pounds because of their good combination of modulus and properties, including creep strength, at temperature. Shop characteristics include good formability and weldability.

One of the available alloys is the magnesium-thorium composition, HK31A, which is manufactured in rolled and cast form. Under development is a similar alloy for extruded shapes and forgings. HK31A sheet and plate are available from stock and from current mill delivery schedules in standard sizes from 0.016″ to 2″.

These new magnesium alloys by Dow should be considered for your high temperature requirements. Contact your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, Magnesium Sales Dept., MA 361G, Midland, Michigan.

you can depend on DOW MAGNESIUM DOW

Space Navigation Challenges Engineers

By Peter A. Castruccio

Baltimore—Space, where the absence of atmosphere insures that electromagnetic waves will not be bent, deviated or attenuated, offers an ideal medium for the electronics engineer.

At the same time, the problems of guidance, navigation and communications for future space travelers, and enemy spotting and tracking, fire control and special communications in the event of space wars challenge the electronics engineer.

At first glance, the problem of space navigation appears rather simple because the position of celestial bodies can be accurately predicted. It should merely be necessary to establish an accurate course from the base of departure to the future position of the particular destination desired, taking into account the various forces acting upon the craft.

However, in practice space navigation is made quite difficult by the exactness and accuracy required. A course such as the one described requires not only the exact knowledge of the position and trajectory of celestial bodies, which indeed is very accurately calculable, but it also requires an equally precise knowledge of the not so easily calculable initial direction of travel of the space ship and its velocity.

Extreme Accuracy Needed

An idea of the accuracy involved is indicated in the following example: assume a voyage to the planet Mars is timed to intercept the orbit of that planet at its nearest distance to the earth, which is on the order of 36 million miles. For spaceship speeds of about 12 mi. per second, an error in launching angle of one second of arc would result in a positional error at the end of the trajectory of 500 mi. When one considers that an error of one second is of the order of magnitude of error of the best theodolites under conditions of good observation, one can visualize the difficulty of maintaining a ship to any given trajectory within this order of accuracy.

A more likely error for a very accurate launching system is in the order of a minute of arc. This will yield a final error of 30,000 mi. Assuming that the trip is performed with initial speed of 12 mi. per second, an error in initial velocity of 1% would cause an error at the end of the trajectory of about 500,000 mi. Errors of this magnitude, small compared to the distance traveled, would cause additional fuel consumption at the end of the trajectory in order to place the ship in the correct final orbit.

Early spaceships will have no choice other than to follow very accurate orbits due to the relatively low efficiency of chemical rockets, but better fuels and engines will be developed to give a large degree of freedom in chosen flight pattern. We thus envision two stages in the progress of space navigation:

- **Stage 1**—Chemically-powered ships venture on occasional, carefully timed exploratory expeditions.
- **Stage 2**—Gradual increase of regular "space lines," and the advent of rather heavy space traffic.

During Stage 1, space navigation will be almost exclusively optical, with the eventual existence of earth-based computers linked to the space ship by radio. In Stage 2, we will witness the development of automatic navigation aids.

The Author

Dr. Peter A. Castruccio at the age of 21 won his doctorate summa cum laude in electrical engineering in 1946 from the University of Genoa, Italy. Born in New York City, the son of a diplomat, Dr. Castruccio served in the British Secret Service during World War II, performing intelligence missions behind enemy lines at the age of 19. Twice captured, he was under death sentence at the time of the war's end.

Returning to the U. S. in 1946, Dr. Castruccio joined Bendix Radio, later the Glenn L. Martin Co. At the present time Dr. Castruccio is an advisory engineer in the missile sub-systems engineering group of Westinghouse Electric Corp. Air Arm Division, Baltimore.

Navigation involves a knowledge of one's position and one's velocity vector. In space these quantities are characterized by three parameters each, or six parameters in all. In purely celestial navigation the various heavenly bodies in conjunction with optical instruments are sufficient to determine one's positive position and velocity.

Absolute Position

Observation of the stars is not sufficient to obtain positional information because the stars are so far away that for all practical purposes they are points at infinity. The only information that can be gathered from star observations in space is the direction of the radius vector from the origin of the coordinate system to the ship. To determine absolute position, the magnitude of the radius vector must be known. This can be done with a reasonable degree of accuracy by measuring the apparent diameter of the sun. If we assume an error of one second of arc in measuring the sun's apparent angular diameter, and further assume the ship is at a distance from the sun equal to the earth's distance (approximately 100,000,000 mi.) the resulting error in the magnitude of the radius vector so determined is of 100,000 mi.

Another method of navigation is to perform observations on the planets instead of the stars. This method will yield absolute position with greater geometrical accuracy than the star-and-sun diameter observations, but it requires an accurate knowledge of the position of the planets at any given time. This involves the use of a clock aboard ship.

Observation of the planets for navigation within the orbit of Mars with instruments capable of accuracies of a second of arc and a clock accurate to a hundredth of a second would mean, in most cases, positional errors of the order of 1,000 mi. This indicates navigation by celestial bodies can be quite accurate and would certainly enable the space travelers to find their destination.

Radar Techniques

Guidance can also be obtained by the use of radar techniques. Thus, beams similar to those used in radio navigation of aircraft could be established in space.

The principal difference between present-day beams and space beams is

that earth based beams are fixed with respect to an earth frame of reference, but space beams will of necessity move with respect to the solar system's frame of reference. This complicates the problem because both the guiding beam and the guided ship move relative to the point of arrival. Nevertheless, such a beam system still could be conceived in several forms:

- **Beams aimed between planets,** forming polygons of variable sizes, the sides of which represent shortest geometric distances between planets.
- **Swept beams** which cover periodically a large section of space.
- **Broad or omnidirectional beams** which provide an intercept course and open the possibility of a proportional navigation system.

Of these possibilities, the first appears interesting because it would allow the spaceship to operate in much the same fashion as a beamrider missile. The beamrider is a very convenient system for guidance, but it displays several disadvantages such as a longer, and therefore uneconomical, flight path and extremely high terminal accelerations. This form of guidance is definitely reserved for the fast spaceships of the future.

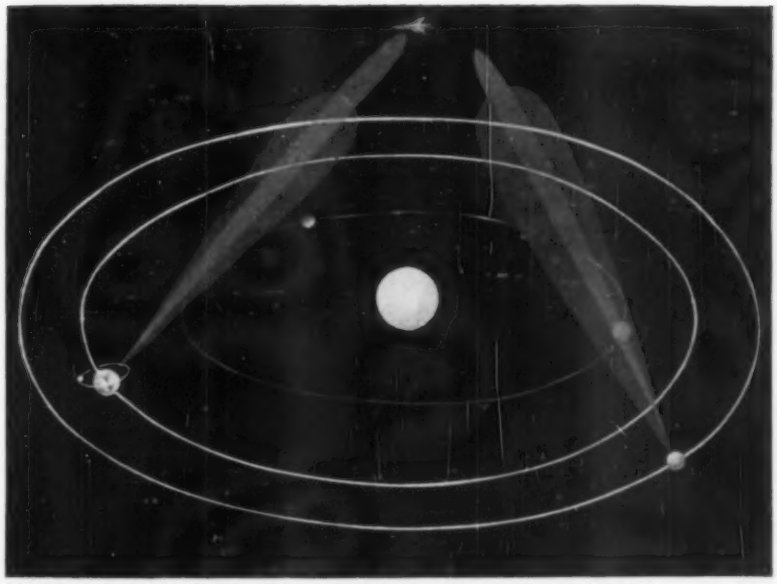
Also, it could not guide the ship all the way to its destination planet, but would require a terminal phase of guidance because of the high terminal accelerations required.

Using the third approach, the beam would be located on the base of arrival, and the ship could navigate in much the same fashion as an interceptor (proportional-navigation) homing missile.

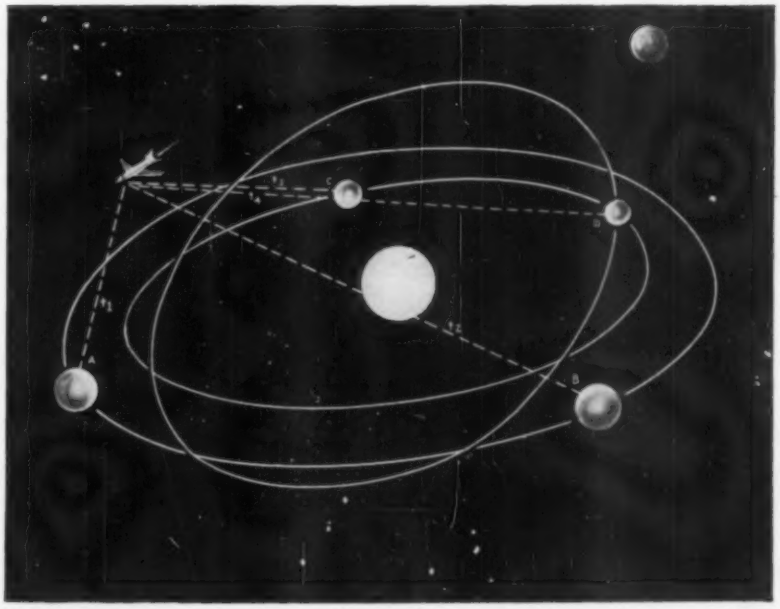
This type missile automatically follows the shortest straight-line course to the target. In such a case, the beam would need to be broader than in the previous cases, and possibly it could be an omnidirectional radiating source. Navigation in this case would at least be simple in theory. The ship's pilot would select the particular frequency corresponding to the destination point, and the automatic mechanism within the ship would do the rest, always maintaining the ship in a shortest-distance collision course.

The source of the beam could be located on the planet of arrival, or on a satellite of the planet—either artificial or natural. Because of the rotary motion of all these bodies, the beam would have to be rotated in synchronism. In the case of an omnidirectional radiator, several would have to be installed on the surface of a planet so as to avoid casting a shadow when the beacon is turned away from the ship.

An antenna of 30 ft. diameter operating at a 3 centimeter wave length (X-band) could theoretically guide a ship from an Earth base to Mars at its closest distance with an accuracy of 10,000 mi. This compares very favorably with accuracies quoted for celestial navigation; however, it is probably an unnecessarily high accuracy.



RADAR BEAMS, like those used for missile guidance, might be employed for space navigation, permitting automatic guidance of vehicles to within 10,000 mi. of destination.

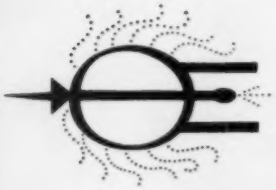


LORAN-TYPE system, using four omnidirectional beacons installed on planets or satellites whose orbits around sun are known, is another possible approach to space navigation.

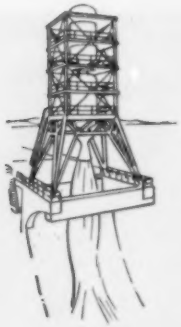
Basic problem of beam guidance is range. Range can be increased by narrowing the beam, but the beam becomes more difficult to locate by the ship. An idea of the range achievable with predictable techniques can be obtained by considering that a transmitting system sending a beam 24 deg. wide with a power of 10 kw. average will have a reliable range of about 140 million mi., assuming a receiving antenna 10 sq. ft. in area and a very good (1 db.) receiver.

Greater ranges can be obtained by increasing the gain of the receiving antenna by the simple expedient of increasing the frequency. Thus, if receiving and transmitting antennas possess 24 deg. beam, the maximum range could be increased to 2.1 billion miles, satisfactory for traffic within the orbit of Uranus. Even an unskilled navigator equipped with maps and optical instruments would be able to effect a crossing

SOLID ENGINE AND CHEMICAL DIVISION



Dependable, simple—the solid-propellant rocket is unique in America's arsenal. Its power is instantaneously unleashed, its performance unaffected by atmosphere and actually improved by altitude. Aerojet-General's jet-assisted takeoff units (JATOs) are the world's most widely used auxiliary power-plants for aircraft.



In the search for new materials of construction, new fuels, and higher thrusts, Aerojet-General offers unequalled opportunity in America's most comprehensive rocket propulsion program.

Mechanical Engineers
Electronic Engineers
Chemical Engineers
Electrical Engineers
Aeronautical Engineers
Civil Engineers
Metallurgists
Chemists
Physicists
Mathematicians
Technical Editors

Aerojet-General CORPORATION
A Subsidiary of The General Tire & Rubber Company
AZUSA, CALIFORNIA
SACRAMENTO, CALIFORNIA

Write: Director of Scientific and Engineering Personnel, Box 296N, Azusa, Calif, or Box 1947N, Sacramento, Calif.

with the beam, and then be guided by the beam.

It should be noted that use of the beam will yield a direct measurement of the ship's velocity with respect to the source of the transmitted energy by employing the doppler effect, provided the frequency of the beam is known.

Another navigation system employs beacons and is similar to the presently used Loran (long-range navigation) system, except that Loran operates in two dimensions and the space navigation system must operate in three. (See sketch, p. 83). Thus, at least four omnidirectional transmitting beacons could be set up in known orbits around the sun. Position of the ship within the Solar System can be determined by measuring the differences in times of arrival of pulses issued by the four beacons, which would have to transmit pulses synchronous in time similar to the Loran system.

Difficulty for space navigation is the requirement that this system be omnidirectional limiting range compared with directional beams. An omnidirectional beacon transmitting an average power of 10 kw. used with a 10 sq. ft. receiving antenna and a good receiver displays a reliable range of about 10 million miles. This range is far too limited for interplanetary flight.

Better Techniques

Future advances in communications techniques should improve this situation. For example, it is known that the noise generated within a receiver limits its ability to discriminate between signal and external noise, thereby cutting its sensitivity. It is also known that this internally generated receiver noise is reduced when the temperature of components is reduced. Making use of the very low temperatures of space, it should be possible to cool a receiver sufficiently to obtain a three-fold increase in range.

An additional advantage may be gained from the fact that interplanetary distances being very large compared to the speeds, there is a greater length of time available to observe the signal. This situation presents an advantage over ordinary earth communications where time is limited to the high speed of aircraft with respect to the distance traveled. The longer the time to observe a signal, the better the signal can be distinguished over noise.

To utilize this advantage fully, certain techniques are required which today are still experimental. If a time span of one minute is allowed for observation, receiver is cooled, and increased time is fully exploited, range can improve to 300 million mi. This range would be suitable for navigation within the orbit the Asteroids.

It is difficult at the present time to predict what advances in information theory can be expected; however, an estimate of an additional factor of 10 is not too far fetched. This would further increase range to 1 billion mi., entirely satisfactory for navigation within the orbit of Saturn. Even without such improvement, the further into space one goes the longer the time required for the trip and consequently the time for observation.

Since range increases approximately as the square root of the observation time, it becomes apparent that observation times of the order of 10 minutes would yield ranges of 1 billion miles. Besides, Solar Systems planet orbits all lie approximately in a plane. Thus, space navigation within the Solar System may well be confined within this plane, unless other noteworthy objects are discovered in other regions of space, an unlikely possibility in the light of our present knowledge.

Narrow Sector

Thus the beacon's radiation pattern need be omnidirectional in azimuth but confined to a relatively narrow elevation sector further increasing the beacon's range. If the vertical radiation be confined to a 10 deg. sector, a range of about 4 billion mi. could be achieved with 1970 techniques and with a 10 minute signal observation time.

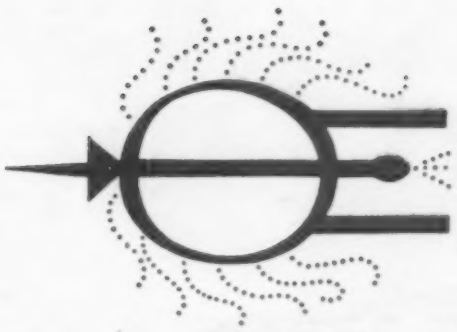
It appears reasonable to predict that such a navigational system employing beacons will be feasible by the time space travel is accomplished. The beacon system will enable the spaceship to determine not only its position, but also its velocity vector by making use of the doppler frequency shift. The receiver would detect four different frequencies separately and be equipped with automatic means to measure the difference in arrival time of the four pulses and thus compute the position of the spaceship within the Solar System. Use of the doppler technique will also enable the ship to compute automatically its velocity vector. And so the ship can be automatically located in space.

It is possible, and perhaps desirable, to locate the beacons on planets or on satellites which already possess accurately known orbits.

Next problem facing the space traveler is communication, base-to-ship and ship-to-ship. Base-to-ship communications have the advantage that a very powerful station can be set up on the base for transmission to the ship.

Assuming the base to be equipped with an omnidirectional transmitter with a power average of 100 kw. and that the space ship carried a 10 sq. ft. receiving antenna, single sideband type voice transmissions should have a range in the order of 6.2 million mi.

Increasing the transmitter power



صفة بيضة تخرج وتحرق

er-Rammah's self-moving egg

Join two flat pans; fill with an incendiary mixture; add a tail; propel by two large rockets. In A.D. 1280, Arabia's Hassan er-Rammah, gazing centuries ahead, proposed this ovoid in his "The Book of Fighting on Horseback and with War Engines."

Today, rocket-powered ordnance is foremost in American defense...and Aerojet-General Corporation is foremost in rocket power. Aerojet's solid-propellant rockets are used on the Sparrow and Regulus and on the newest, most advanced American missiles.

Aerojet-General CORPORATION

A Subsidiary of The General Tire & Rubber Company

AZUSA, CALIFORNIA
SACRAMENTO, CALIFORNIA

We invite you—the engineer, the scientist—to participate at Aerojet in the creation of tomorrow's realities from yesterday's dreams.

for engineer's wives only

Here is a unique opportunity that appeals to both you and your husband.

For you wives and families, the opportunity to live in a wholesome environment in the heart of the Colorado Rockies. For you engineers, the opportunity to participate in a challenging engineering project with an unlimited future.

for detailed information write to
Emmett E. Hearn, Empl. Dir., Dept. K-5, Box 179, Denver 1, Colorado

MARTIN
DENVER DIVISION

would help since range is proportional to the square root of the power; however, this "brute force" method requires base installations with power out of all proportion. For example, if transmitter power were increased to 2 million watts, the range would only increase by a factor of 4.5, yielding a total range of 28 million miles.

When one considers that the most powerful radio transmitters in the world today transmit about 1 megawatt, one can visualize the tremendous powers required for such communication.

Omnidirectional communication, however, can be improved considerably by using beamed communication in which the transmitted power is sent out on a beam and reaches only the ships that are in the beam path. What is gained in increased range is lost in reduced coverage. By using a 24 deg. beam, and reverting to the 100 kw. power of the example, a range of 62 million miles could be achieved or 200 million miles with one megawatt.

Beam type communication requires either a knowledge of where the spaceship is, or requires sweeping the region of space where the ship is thought to be, until the ship is found. A three-fold increase in the range can be obtained, as previously explained, by cooling the receiver, but the factor of extended time reception will not be as favorable. In voice communications, it is desired to convey the message immediately.

Coded Communications

Telegraphic or code communications could wait for extended periods of time to achieve increased range. In this latter case, communication would be spread out in time, i.e., a message which would normally take one minute to deliver would require a considerably longer interval. If a one-minute message is spread out to one hour, an eight fold increase in range can be anticipated. A large antenna could be erected from the spaceship to capture more of the transmitted energy. In this manner, areas of perhaps 100 square meters could be achieved with a theoretical increase in range over the previous example by a factor of 10. With the cooling technique plus the auxiliary antenna technique, the range for communication could be increased to about 600 million miles with one megawatt transmitted power, which is a rather respectable figure.

Actually the ship is probably known to be lying in one octant with a consequent increase in range of a factor of 2.7, yielding a total range of about 1.6 billion miles. Again it is quite possible that future advances in techniques may further extend the range.

The situation for communication from the ship to the base is somewhat different. Unless future advances in

AIRCRAFT TRANSDUCERS

PRESSURE OPERATED POTENTIOMETERS

Outputs: Linear and nonlinear functions of applied pressure.
Resistances: 100 to 50,000 ohms.
Ranges: 0-5 to 0-5000 psi.
Types: Absolute and differential.
Vibration Ambient: 0 to 55 cps, 0 to 500 cps, and severe vibration 25g to 2000 cps.
Construction: Hermetically sealed.

Write for Pressure Operated Potentiometer Bulletin

ULTRA-SENSITIVE PRESSURE SYSTEM

Output: 50 volts at full scale.
Range: ±¾ psi, differential.
Resolution: 1 x 10^{-6} psid.
Zero stability: Better than 1 x 10^{-3} psid.

Write for Bulletin EPMS

RESISTANCE BRIDGE PRESSURE PICKUPS

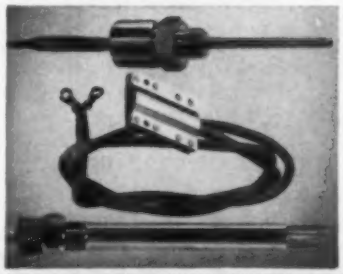
Sensitivity: 5 mv/v at full scale.
Ranges: 0-10 to 0-1500 psi.
Types: Absolute and differential.
Construction: Hermetically sealed.

Write for Bulletin No. 7

RATE OF CLIMB

Outputs: 5 volt signal and/or dial indicator.
Range: ±25,000 ft./min.
Time constant: 0.2 sec. at sea level to 2 sec. at 50,000 ft.

Write for Vertical Speed Transducer Bulletin



RESISTANCE THERMOMETERS

Resistance: 5 to 500 ohms at 32°F.
Materials: Platinum or nickel.
Range: −350 to +2000°F.
Types: Liquid, surface, gas.
Characteristics: Corrosion proof, severe vibration ambient, fast speed of response.

Write for Resistance Thermometers Bulletin

"For Transducers See Trans-Sonics"

Trans-Sonics, Inc.

P.O. BOX 328 • LEXINGTON • MASSACHUSETTS

Fully Floated Miniature Free Gyros By Daystrom Pacific Corporation Help Assure PRECISE CONTROL!

Thousands of man hours are spent by top men in the control field to develop exactly the right components to assure the precise control of each missile.

Components available from Daystrom Pacific Corporation, such as the small, amazingly reliable and accurate F10A-1 FREE GYRO, help in forming the exactly right control systems. The top team of engineers and technicians at Daystrom Pacific Corporation have produced some of the finest system components in use today.

The F10A-1 Free Gyro Meets All Known Missile and Aircraft Specifications - - -

A few "Specifics"

Drift Rate—0.1°/min. maximum
Vibration—Operations through 15G's from 10 to 2500 cps as required
Acceleration—100G's along any axis
Caging Accuracy—Within 0.1°
Uncaging Cycle—0.030 to 0.050 sec

(Pick-offs can be AC synchro, AC resolver, or DC potentiometer — a comprehensive selection of AC or DC motors is available.)

Openings exist for highly qualified engineers.

Write For Complete Product Information

Control Systems, Stable Platforms, Miniature and Sub-miniature Rate Gyros, Vertical Gyros, Free and Directional Gyros, Accelerometers, Integration, Intervalometers, Potentiometers, Synchros, Resolvers, Sensing and Actuating Components.

AMERICAN GYRO DIVISION

Daystrom PACIFIC CORPORATION

A subsidiary of Daystrom, Incorporated

3030 NEBRASKA AVE. • SANTA MONICA, CALIFORNIA

CONTROL SYSTEMS, STABLE PLATFORMS, MINIATURE AND SUB-MINIATURE RATE GYROS, VERTICAL GYROS, FREE AND DIRECTIONAL GYROS, ACCELEROMETERS, INTEGRATION, INTERVALOMETERS, POTENTIOMETERS, SYNCHROS, RESOLVERS, SENSING AND ACTUATING COMPONENTS.

the art will make transmitted powers of the order of a 100 kw. or more practicable for ship-borne equipment, the spaceship is probably limited to much smaller powers than base stations. The ship, however, has the advantage that it knows where the base is and thus can employ the beaming technique.

Assume that the ship can conveniently carry a one kilowatt transmitter, then by using a 2 deg. beam, a range improvement of 125 times the omnidirectional case is achieved. At first sight, it appears that a one kilowatt transmitter with a 2 deg. beam-width antenna would yield maximum range of 125 times 6.2 million miles or of about 2.2 billion miles. Such an improvement is predicted on having a one square meter or a 10 sq. ft. receiving antenna at the base.

Wave Length Size

If the transmitting antenna is to emit a two degree beam and have a reasonable size, the wave length should not be less than 30 centimeters. This means that the receiving antenna at the base will automatically become beamed (because its area is large compared to the wavelength) or must be reduced in size in order to give omnidirectional properties. This reduction in size means reduction in range.

Rather than reduce its size, it may be more practical to sweep the receiving antenna at the base and look for an intercepted signal. After all, at the base there is still a reasonable knowledge of the position of the spaceship, and thus some degree of beaming can be achieved. It should be noted that in the previous example (assuming a 100 sq. ft. antenna on the spaceship and a 2 deg. beam) the beaming required at the base with a 10 sq. ft. antenna, is only 15 deg., which may be entirely satisfactory in most cases. It appears then that ship-to-base communications can be obtained with reasonable means.

It is also entirely possible that nuclear energy may provide great sources of electrical power, and that advances in the art may provide very light and compact transmitting devices capable of extremely high output power. It was noted that all the observations theretofore made are simply extrapolations of the present state-of-the-art into the rather near future, let us say within the next 10 to 20 years.

The next problem confronting space travelers is that of spaceship-to-spaceship communications. At the outset, communication between very distant spaceships seems rather pointless. Such communication can always be relayed through ground bases or beacons. It is also conceivable that in order to reach an outlying ship special transponder beacons may be set up. The first ship would aim at the transponder beacon

PIONEERING is our business

SERVICING LIQUID OXYGEN MADE SAFER AND EASIER BY NEW BENDIX DUAL INDICATION

Bendix capacitance type liquid oxygen quantity gage systems now offer *dual* indication—in the cockpit and at any desired point on the airplane.

Two important advantages are gained when an indication is located near the servicing point:

1. The mechanic can check the liquid oxygen supply in the system quickly and easily from the ground as part of his regular line maintenance.

2. In replenishing the liquid oxygen supply, the serviceman gets a continuous reading *right at the point of servicing*, so that he knows exactly when the converter is filled, rather than having to wait for the liquid oxygen to spill out the vent valve—with the hazards that inevitably accompany such a procedure.

Bendix systems for measuring liquid oxygen levels are completely transistorized to meet critical space and weight limitations. They work with both single- and multiple-converter installations and are adaptable for use in missiles.

For full details, write PIONEER-CENTRAL DIVISION, BENDIX AVIATION CORPORATION, DAVENPORT, IOWA.

West Coast Office: 117 E. Providencia Ave., Burbank, Calif.
Export Sales & Service: Bendix International Division, 205 E. 42nd Street, New York 17, N. Y.
Canadian Affiliate: Aviation Electric Ltd., 200 Laurentien Blvd., Montreal, P. Q., Canada

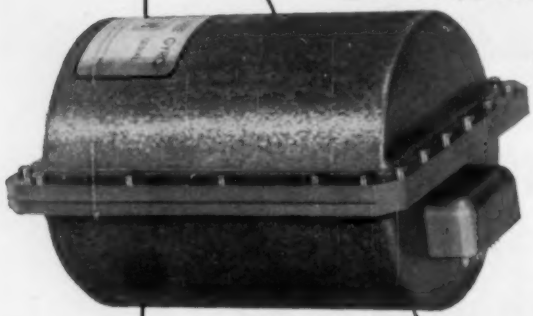
Pioneer-Central Division

Bendix
AVIATION CORPORATION

THE HEART OF THE HOMING SYSTEM

Doelcam
Master-precision Gyroscopes

DOELCAM Master-precision Gyroscopes and Gyro Stable Platforms are standard equipment in many of today's missile and aircraft stabilization and guidance systems. Shown here are three standard models. Specialized versions of these models or completely new designs can be produced in quantity to suit your requirements *exactly*. Avail yourself of the same engineering know-how that has successfully designed gyros for the LARK, METEOR, TALOS, RASCAL, BOMARC and LACROSSE Missiles and the same production team that has made DOELCAM the largest single producer of gyros for the bombing and navigational computer used in the B-36, B-47 and B-52. ***We invite your inquiry.***



Cageable Free Gyroscopes, Type CFG-P (Potentiometer Pickoff) and **Type CFG-S** (Synchro Pickoff) for guided missile instrumentation and control systems. These gyros measure angular deflection about either one or both gimbal axes. The rugged simplicity of the caging mechanism and the rail-type mounting enable these gyros to withstand severe shock and vibration. Weight — 5⅛ lbs. Size — 5 19/32" long x 4⅜" diameter (exclusive of mounting flange). Drift—less than ¼° per minute. Remote caging and uncaging. ***Write for Bulletin CFG. 11***

Rate Measuring Gyroscopes, Type K for guided missile control and homing systems and flight evaluation of military aircraft. These models measure absolute angular rates where high accuracy and superior dynamic response are essential. Linear output signal proportional to input rate within 0.25% of full scale. Withstand 100G shock in any plane and 15G vibration up to 2000 cps. Weight—3⅝ lbs. Size—5¾" long x 3.20" diameter. ***Write for Bulletin KG. 11***

Rate Measuring Gyroscopes, Type JR for tactical weapon systems requiring less than one minute warmup. Incorporate damping compensator for constant damping ratio without heater. Linear output signal proportional to input rate within 0.25%. Withstand 50G shock, 15G vibration up to 2000 cps. Angular Momentum — 10^6 gm.-cm.²/sec. Size 3⅜" long x 2.0" diameter. ***Write for Bulletin JR. 11***

Doelcam

A DIVISION OF MINNEAPOLIS-HONEYWELL

SOLDIERS FIELD ROAD
BOSTON 35, MASS.

Instruments for Measurement and Control

Synchros • Gyros • Amplifiers • Microsyns • Servo Motors

with its limited power but with a highly beamed antenna and deliver its message. The transponder beacon would then rebroadcast the message at high powers.

This situation would rapidly lead to problems of assignment of transponder time as space traffic increased. Transponder beacons rapidly would become saturated, eventually only be used for emergency messages. Limiting ourselves to communications between reasonably close spaceships, let us see what can be achieved.

Assuming omnidirectional broadcast, a 10 sq. ft. antenna, one kilowatt of transmitted power, and voice communication, a range of 0.62 million miles can be achieved. With cooling of the receiver, the range can be increased to about 1.8 million miles. These parameters dictate a wave length of about 1.6 meters, corresponding to a frequency of the order of 200 megacycles. An increase in range can be had by increase in the transmitted power. If future advances will enable the ship to carry a 100 kw. transmitter, a range of 18 million miles could be achieved.

Beaming Techniques

Another considerable improvement can be obtained by employing beaming techniques. Of course, the beaming technique implies a knowledge of the position of the other ship. If there is no such knowledge, recourse must be had to scanning, which means searching successive regions in space and listening for a reply.

Scanning would be complicated in space because a considerable delay between transmission and reception would be experienced. The speed of light being 186,000 mi. per second, an interplanetary distance of 36 million miles as that between Earth and Mars at their closest point results in a delay of close to 4 minutes. Thus a complete round trip transmission between two space ships 50 million miles apart would take close to 8 minutes.

In order to establish contact, the transmitting ship would have to wait for duration of a complete round trip of a transmission plus a reasonable length of time to assure that the message was heard. However, this may be avoided by employing a memory of the successive antenna positions. In this manner the antenna could transmit its message say for one or two minutes in each direction, then move off to a new direction. If, six or eight minutes later, a received message appeared, it would only be necessary to have memorized antenna positions with respect to time to enable the transmitting ship to slew its antenna back.

It should be noted that beaming will involve higher frequencies than the HF and most likely it will require going into the VHF or microwave region in

are you running behind in the vicious race for qualified research and production men?

FOR HIRE experienced technicians with qualifications you want

The critical shortage of experienced physicists, engineers and production craftsmen needn't curtail your output—reduce your profits. The Mechanical Division of General Mills has trained men and specialized machines ready today to handle your design requirements and production of

- **electro-mechanical systems or components**
- **fine-pitch, instrument-type gears**
- **precision parts, cutting, grinding, finishing**
- **industrial or military optical assemblies**

You get the type of engineering and manufacturing you're proud to call your own. You meet delivery dates. You eliminate capital expenditures for plant expansion. *And*, you get out of the vicious race for men qualified to do the job the way you want it done.

Our reputation for creative research and precision production has been built over 16 years of ordnance and instrument work for the world's most exacting customers. You can join this group profitably.

RESERVED FOR YOU: this interesting, fact-packed booklet Send today. Booklet shows our facilities, names our customers. It introduces you to on-time, precision production. Write Mechanical Division, Dept. AW91, General Mills, 1620 Central Ave. N.E., Minneapolis, Minn.

***MECHANICAL DIVISION OF* General Mills**

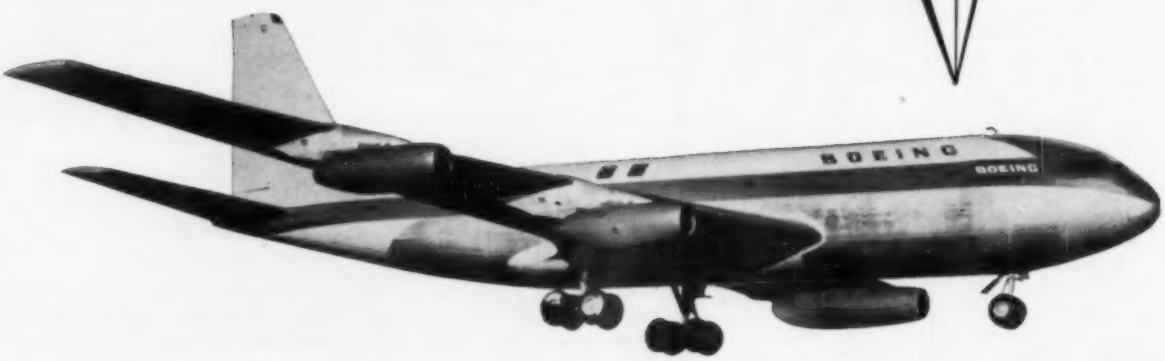
WHETHER

YOU

FLY

THE

BOEING 707.....



.....OR THE

DOUGLAS DC-8.... *you'll take off and land on CPT landing gear*

Out of CPT's 30-year experience came the engineering and drawings for the landing gears for both these American all-jet intercontinental transports.

And out of CPT's giant precision manufacturing facilities are coming the landing-gear ship-sets to speed the day when fleets of DC-8's and 707's will fly on scheduled flights.

Put CPT's wealth of experience and facilities to work now on your projects of Tomorrow. No other landing-gear builder has CPT's combination of experience, knowledge, and facilities.

ENGINEERS: If you would like to work at CPT on airframe-component design problems, write us. Liberal profit-sharing and retirement plan, modern plant and facilities.

CPT

CLEVELAND PNEUMATIC TOOL CO.

3781 East 77th Street • Cleveland 5, Ohio

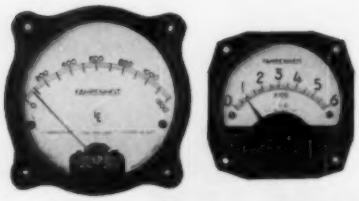
Sales-engineering offices in
Seattle, Los Angeles, Fort Worth-Dallas and Levittown, L.I.

LEWIS
Indicating Pyrometers

for temperature testing in the laboratory or in the plane...

Constructed with the same care as our aircraft temperature indicators, these pyrometers bring "aircraft quality" to the test engineer.

MODEL 58PY, above, has been used extensively by leading motor car manufacturers for road testing on the "Proving Grounds" — where performance counts. Housed in rectangular bakelite case, has 6" hand drawn scale and is fully compensated for ambient temperature. Made in ranges listed below, with suitable thermocouple materials.



MODEL 23B, left above, has same type movement as our aircraft pyrometers. Housed in flanged, 4" round, bakelite case for panel mounting.

MODEL 20B, right above, has same 3" steel case and same movement as our aircraft panel indicators. Both are fully cold-end compensated and available in standard ranges listed, with suitable thermocouple materials.

STANDARD RANGES—All Models

FAHRENHEIT

Zero to 400, 600, 800, 1000, 1200, 1600, 1800, 2000 and 2500.

CENTIGRADE

Zero to 200, 300, 400,, 500, 600, 800, 1000, 1100 and 1400.

Furnished with white scales, black markings and pointer or, with black scales white markings and pointer if specified. For best results use LEWIS Thermocouples, Leads and Selector Switches with these instruments.

THE LEWIS ENGINEERING CO.

Manufacturers of Complete Temperature Measuring Systems for Aircraft

NAUGATUCK, CONNECTICUT

view of the limited space available for the transmitting and receiving antennas.

Although it now appears that the probability of encounter with meteorites is extremely low (so is the probability of colliding with another spaceship), it is interesting to investigate what might be done to avoid at least the large meteorites. An anti-collision radar would be difficult because of two factors.

- **Small size** of the meteorites.
- **Large frequency** shift caused by doppler effect.

Effective anti-meteorite radar must be able to protect the ship against fairly small objects. A one pound metallic core meteorite traveling at relative speeds of several tens of miles per second can cause considerable damage. Such a meteorite has a cross sectional area of approximately a tenth of a square foot. If the meteorite is irregular in shape and rock coated, its radar cross section would be of the same magnitude as its geometric cross section.

Let us assume a tenth of a square foot as the radar cross section of the smallest meteorite which we desire to defend the spaceship against. It is well known that the radar range increases with the size of the antenna, but of course aboard the ship the antenna size will be limited. Let us assume a size of one square meter, corresponding to a diameter of about 4 ft. It is also known that the higher the frequency of the radar, the higher the degree of beaming achievable and consequently the higher the searchlight. Let us assume that our space radar employs a wave length of 4 millimeters. Let us further assume that this radar employs a peak power of 100 kw. It should be noted that these parameters could probably be achievable within the next 10 to 20 years.

The next problem in radar design is that of bandwidth, which must be large enough to allow for the passage of information. It must not be too large or noise will also pass and tend to drown out the signal. In this connection, the doppler shift enters the picture. Assuming a relative speed between ship and meteorite of 40 mi. per second, which is quite possible for a head-on-course, the doppler shift at this wave length is of the order of 40 megacycles. This means that the receiver must be at least 30 megacycles wide because the doppler shift can occur anywhere from zero up to 30 megacycles, depending on the relative speed between ship and meteorite.

The next step in our calculation is to assume a system loss. We are aware of the fact that every radar system performance suffers from losses in the transmitting and receiving elements, losses in the conversion element, deterioration due to aging, etc. We will assume

NEW METER-RELAYS
FROM 0-5 MICROAMPERES-UP

Ruggedized - Sealed, Black Bakelite or Clear Plastic Cases

D'Arsonval meters with locking contacts for sensitive and accurate control or alarm.

Model 461-C, 10-0-10 Ua DC **$83.25**

TRIP POINT ADJUSTABLE to any point of scale arc. Sensitive to changes as little as 1%. One contact on moving pointer. The other on adjustable pointer. When pointers meet, contacts close and lock. Holding coil wound on moving coil. Locking is electro-magnetic. Manual or automatic reset. Spring action kicks contacts apart.

Ranges: From 0-5 microamperes, 0-5 millivolts or 0-300°F up.

Standard Contact Rating 5 to 25 milliamperes DC. Can be up to 100 milliamperes DC.

Ruggedized-Sealed metal cases, 2½", 3½" or 4½" round, shock-mounted movement, gasket-sealed.

Black Bakelite case, 4½" rectangular.

Clear Plastic cases, 2½", 3¾" or 4½" rectangular.

Model 255-C, 0-10 V DC **$42.50**

Panel meters and indicating pyrometers also in ruggedized-sealed, black bakelite or clear plastic cases. Write for new 40 page Catalog 4A on meter-relays, meters, pyrometers and automatic controls.

Assembly Products, Inc., Chesterland 50, Ohio. HAmilton 3-4436 (West Coast: Desert Hot Springs 50, Calif. Phone: 4-3133 & 4-2453).

Booth 1614, Instrument-Automation Show, Sept. 17-21, New York Coliseum

Now!... the NEW ROBINSON WIRE TWISTER
with DIAGONAL GRIP-HEAD

Faster, more efficient than ever! The new, slendernose DIAGONAL GRIP-HEAD is designed especially for those narrow- hard-to-reach places. Split-second whirling action safety-wires 3 engines in time required for one by any other method . . . saves as much as $140 per engine assembled.

3-TOOLS-IN-1 . . . pliers-cutters-twisters. Side-cutting, oil-tempered head. Permanent bronze bearing. No adjustments. Jaws lock on wire, can't slip off. Perfect, uniform twist every time.

12" —for assembly line safety wiring, 15 oz. **$21.50**

9" —for bench work, sub-assemblies, 12 oz. **$20.50**

Unconditional Money-Back Guarantee. Send for complete details.

RALPH C. ROBINSON CO.
Box 494W No. Sacramento 15, Calif.

Canadian Distributor, Gensales, Ltd., Malton, Ont.

From the Laboratories Famed for Precision Compasses

THE NEW C-10 GYROSYN*

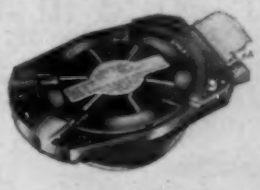
...a Complete "World-Wide" Compass System Meeting Advanced Specifications for Polar Flight—**Yet Weighing Only 20 Pounds!**

MASTER INDICATOR
Approx. weight 4¼ lbs.
Cut-out Dia. 3⅛ inches
Clearance behind panel 10⁹⁄₁₆ inches

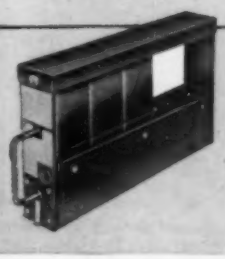
CONTROLLER
Approx. weight 1 lb.
Height 2⁴¼₄ inches
Length 5¾ inches
Clearance behind panel 3¹⁵⁄₁₆ inches

DIRECTIONAL GYRO
Approx. weight 8¾ lbs.
Width 7³⁄₃₂ inches
Height 7½ inches
Length 8³⁄₃₂ inches

FLUX VALVE
Approx. weight 1½ lbs.
Width 3½ inches
Height 2¹¼₄ inches
Length 4²³⁄₃₂ inches



RACK ASSEMBLY
Approx. weight 5 lbs.
¼ ATR
12¾ inches long



For more than a decade, Gyrosyn compasses by Sperry have set the standards of the aviation industry for commercial and military aircraft alike. Every day, hundreds of thousands of precision, on-course miles are flown with the aid of these accurate and dependable instruments. Yet in the Sperry laboratories the search for even greater accuracy and precision never ends—as evidenced by Sperry's most recent development, the C-10 Gyrosyn.

THIS IS PRECISION

At latitudes under 65° where the C-10 Gyrosyn is "slaved" to magnetic headings, accuracy is assured within ¾ of a degree. At latitudes above 65°, where magnetic headings are unreliable and the C-10 Gyrosyn is unslaved, random drift is less than 3° per hour. This compares with an average random drift of 8° to 16° per hour with many slaved compasses in use today.

THIS IS EFFICIENCY

A separate latitude corrector also automatically compensates for earth rate drift of the gyro, whether slaved or unslaved. Reliability of the system is further assured through the direct-drive nature of the master indicator which precludes transmission errors common to repeater-type instruments.

THIS IS THE ANSWER

. . . for today's faster-flying conventional aircraft and for tomorrow's turbo-prop and jet airliners. The C-10 Gyrosyn is recommended as the directional component of the SP-30 Flight Control System and the Integrated Instrument System, both of which are standard in the Douglas DC-8. It can be applied readily to modernize flight instrument equipment in existing aircraft. For complete information on the Sperry C-10 Gyrosyn, as well as other developments in the field of precision instrumentation, write our . . .

SPERRY *Aeronautical Equipment Division*
GYROSCOPE COMPANY
Great Neck, New York
DIVISION OF SPERRY RAND CORPORATION

CLEVELAND • NEW ORLEANS • LOS ANGELES • SAN FRANCISCO • SEATTLE. IN CANADA: SPERRY GYROSCOPE COMPANY OF CANADA, LIMITED, MONTREAL, QUEBEC

*T. M. Reg. U. S. Pat. Off.

THIS IS FOR YOU ... IF YOU HAVE AN AC GENERATOR COOLING PROBLEM!

SPECIFICATIONS

208/120 Volts, 0.75 Power Factor, 3 Phase, 400 CPS

Type No.	Rating KVA	Rated Cooling Air Pressure in "H_2O"	Rated Cooling Air lb./min.	Diam. in.	Speed RPM	Approx. Weight lbs.	Flange and Drive Spline
*28E16-1	20	4	11	8.25	5700-6300	60	AND 10266 XVI-A
*28B23-1	20	4	11	8.25	4800-7200	65	AND 10262 XII-A
*28E17-1	30	8	14	8.25	5700-6300	69	AND 10266 XVI-A
*28E14-1	40	5	14.5	9.25	5700-6300	83	AND 10266 XVI-A
*28E15-1	60	6	16	9.25	5700-6300	103	AND 10266 XVI-A
28E19-1	10	4	7	6.5	7600-8400	30	AND 10262 XII-A
28E19-3	10	4	7	6.5	7600-8400	31	New 9" Flange
28E20-1	20	6	8.5	6.5	7600-8400	45	AND 10262 XII-A
28E20-3	20	6	8.5	6.5	7600-8400	46	New 9" Flange
28E21-1	30	10	12.4	6.5	7600-8400	60	AND 10262 XII-A
28E21-3	30	10	12.4	6.5	7600-8400	61	New 9" Flange
**28E10-1	9	6	8.6	6.5	7600-8400	39	AND 10262 XII-A

*These generators include integral fan permitting full load continuously up to 80°C at sea level with no additional cooling.

**This generator incorporates a DC output of 30 volts, 50 amps capacity in addition to the AC output.

All generators have been designed to MIL-G-6099 and MS-33542, which specifies cooling air of 120°C at sea level, 40°C at 50,000 ft., and −12°C at 65,000 ft., and will deliver full-rated load under these conditions.

Bendix Red Bank

HIGH-TEMPERATURE AC GENERATORS

meet military class C air-cooled specifications ... offer maximum performance at minimum size and weight... range from 9 KVA to 60 KVA

These generators are designed as part of complete Red Bank high-temperature AC generating systems that also include magnetic amplifier voltage regulators and system protection components. For full details, write Red Bank Division, Bendix Aviation Corporation, Eatontown, New Jersey.

West Coast Sales and Service: 117 E. Providencia Ave., Burbank, Calif.
Canadian Distributor: Aviation Electric Ltd., P.O. Box 6102, Montreal, P.Q.
Export Sales and Service: Bendix International Division, 205 E. 42nd St., New York 17, N. Y.

Red Bank DIVISION — Bendix AVIATION CORPORATION

ENGINEERS WANTED: Opportunities now available for experienced design engineers to work on aircraft type AC and DC rotary power supplies and associated control equipment and distribution systems. Write today: Attention of Personnel Department K.

here a figure of 6 db (meaning a loss of 4:1). It should be pointed out that this figure is unachievable today at these frequencies, but may be realized within the next 10 to 20 years. Today the very best that could probably be achieved at this frequency is 15 db, which means a loss of 30 to 1.

In order to be reliable, the signal must exceed the receiver noise by several times. This is particularly true in automatic radars, as this must be, because an automatic radar must have a very high probability of not confusing the target with random noise. Again, we will assume that in order to be reliable, the signal must exceed the noise by at least 6 db (factor of four). This again is not achievable today but may be within the predictable future.

We now have all the elements to compute the range by applying the radar range equation. We find that the range of this radar is only 25 mi. Several things can be done now to improve this range. First, we may use special circuits to recover at least partially the loss caused by the wide IF bandwidth. Assuming that this loss can be recovered completely, we find that the range improves to approximately 60 mi.

An additional improvement can be derived by cooling the receiver. In the case of radar, the improvement is not proportional to the square root of the cooling factor as in the one-way transmission, but only to the 4th root because of the two-way transmission. Assuming that the receiver can be cooled to 30 deg. absolute, an improvement of about 1.6 results, yielding a range of approximately 100 miles.

Time Is Short

For a meteorite traveling head-on towards the ship at relative speeds of 40 mi. per second, this range gives us about 2.5 seconds to detect the target, plot its course, determine that it is a collision course, compute the ship's maneuver to evade the meteorite, and evade it. For meteorites traveling broad side to the ship at speeds of 20 mi. per second, the time to do all this is increased to about 5 seconds, a very short time to perform all these functions.

The situation is much better from the rear, assuming that meteorites pursue the ship. If the ship should travel at a speed equal to an average meteorite's speed, then it will leave the slow ones behind and will only be overtaken by the faster ones. These faster meteorites probably will only exceed the speed of the average metorite by a few miles per second. This gives a possible span up to 1 min. to perform all maneuvers.

Thus in regions of space where the meteorite orbits and speeds are known, it is possible to protect against them by traveling in their direction and, of course, at sufficient speeds. Where the

NEW - Air-transportable Control Tower

Flight demonstration at Fort Devens, Mass. of ***Helicop-Hut*** *Air Traffic Control Set.*

Craig

HELICOP-HUT* AIR TRAFFIC CONTROL SET

Requires only 30 minutes to set up for operation.

A highly mobile two-man unit designed for directing and controlling airport traffic; for Civil Defense and weather reporting purposes.

SELF-CONTAINED (except for primary power), includes communications equipment, weather instruments, console, equipment racks, storage facilities, electrical and ventilating systems, miscellaneous equipment.

TRANSPORTABLE by helicopter, cargo aircraft, truck, or special carriage.

LIGHTWEIGHT — 2500 pounds complete with electronic equipment.

COMPACT — 96" long, 76" wide, 54" high; 75" from floor to ceiling of observation dome.

SHELTER CONSTRUCTION—New process—aluminum skins bonded to a plastic foam core give high strength/weight ratio.

For further information, write or phone —

Craig SYSTEMS, INC. *TRADE MARK

Dept. C-9 — Danvers, Mass. Phone: Danvers 1870

Craig also supplies other types of control towers, complete mobile electronic systems and various types of shelters, vans and trailers.

BUMBLEBEES CAN'T FLY!

You've heard the old story!

Rohr engineers, too, are busy every day solving near-impossible problems related to many phases of flight—important, challenging design and production problems on hundreds of vital, major aircraft components.

One example: The development and production of complex stainless-steel, honeycomb sections for high-speed aircraft and missiles.

Rohr is humming these days with more and more large military and commercial contracts.

Skilled engineers are urgently needed to grow with these big, long-range programs. Young men are offered outstanding career positions with unmatched opportunities for advancement within this large, fast-growing aircraft firm.

Especially needed now at Rohr are: *Design, Stress and Structures, Lofting, Equipment, Electrical, Liaison, and Aircraft Industrial Engineers, Thermodynamicists, Metallurgists.*

Write us today! Learn about our sound management policies, personal benefits, chances for quick advancement and other career advantages here at Rohr in beautiful Chula Vista located on cool San Diego Bay.

Please write giving complete details and we will answer at once.
J. L. Hobel, Industrial Relations Manager, Rohr Aircraft Corporation, Chula Vista, California, Dept. 29

WORLD'S LARGEST PRODUCER OF **READY-TO-INSTALL POW-R-PAX FOR AIRPLANES**

ROHR
AIRCRAFT CORPORATION

ENGINEERS:

Aerodynamics & Propulsion

If you can do original work

. . . you should consider The Johns Hopkins University Applied Physics Laboratory (APL), where creative ideas are recognized and supported.

The Laboratory is primarily concerned with research and development of guided missile systems. A sizeable program of fundamental research is concurrently in progress.

APL is responsible for technical direction of the Navy's Bumblebee guided missile program. Developments at APL include the first supersonic ramjet, and the missiles TERRIER, TALOS and TARTAR.

A distinguishing feature of the Laboratory is the self-dependence of the professional staff members, who work in an atmosphere of free inquiry and are unhampered by the usual administrative details. Problems are attacked by teams, each of which maintains a fine balance between research and engineering. The team approach allows each member to acquire broad knowledge, find his creativity heightened.

The locations of the Laboratories in the Washington D. C.-Baltimore periphery place staff members near fine housing in all price ranges, recreational and cultural facilities. Moving expenses paid in full. Liberal educational benefits for study at a number of excellent universities nearby.

OPENINGS EXIST IN:

DEVELOPMENT: stability and control analysis; ramjet engine design

RESEARCH: interference and heat transfer phenomena; hypersonics, turbulence, shock wave phenomena

For additional information write:
Professional Staff Appointments

The Johns Hopkins University Applied Physics Laboratory

8615 Georgia Avenue,
Silver Spring, Md.

direction and speed of the meteorites is unknown, it appears that the radar will provide practically no protection unless some major advances occur in the art.

We have assumed small targets of the order of a tenth of a square foot. Against larger targets the situation is only slightly better. Radar range increases as the fourth root of the target size so that even if we increase the target size by a factor of 100, giving us a 10 sq. ft. target, which corresponds to a 1,000 lb. meteorite, our range would only go up a little over 3 times. This increased range would be on the order of 300 mi. For head-on meteorites, a 300 mi. range radar would give us a warning time of about 8 seconds which still appears too short for all the things that must be done.

In view of the immensity of space, collisions between ships appear at first sight improbable unless we assume a very high traffic density confined to relatively narrow traffic lanes. Between ships, a radio warning system could be used which would have much greater ranges than the radar. Such a warning system could have the approximate ranges calculated previously for the case of ship-to-ship communications and thus even a relatively power ship-to-ship warning system could yield ranges of tens of thousands of miles.

Radar Mapping

Planetary mapping is of course best done by optical means. Only in cases where planets are covered by clouds either permanently or temporarily, such as Venus, would radar mapping be desirable and worthwhile. In addition to mapping, radar techniques can be used to some extent to determine the make-up of the planet's atmosphere. Different gases or combinations of gases possess different absorption characteristics at different frequencies. One could thus gain an insight into the constituents of a planet's atmosphere by measuring the weakening of the radar echo from a fixed point on the planet's surface as the radar frequency is varied.

An even better method would be the launching of a radar beacon transponder which could be parachuted to the planet's surface. This beacon would be equipped with a constant-power broadband repeater which would re-transmit the frequency with which it is being interrogated by the ship.

A weakening of the returned signal at a wavelength of 1.25 centermenters (K-band), for instance, would indicate the presence of water vapor. A strong attentuation at 5 millimeter wavelength would detect the presence of oxygen. The amount of weakening would reveal the content of oxygen in the planet's atmosphere. This beacon technique should be well developed by 1970.

BILL WHITESIDES—
Engineering Manager
Flight Refueling, Inc.

Graduate of Texas Tech with 18 years experience in power plant and fuel transfer design.

BILL WHITESIDES' ENGINEERING STAFF NEEDS:

DESIGN ENGINEERS

1 to 3 YEARS EXPERIENCE

Just the spot for you if . . .

- If you're ready to make a change
- If you're lost in a large organization
- If you're interested in new career opportunities

Bill needs young men with ideas NOW to join his hard-hitting team or aerial fueling specialists

Ideal working conditions and close proximity to modern communities bordering on Chesapeake Bay and the Severn and Magothy River

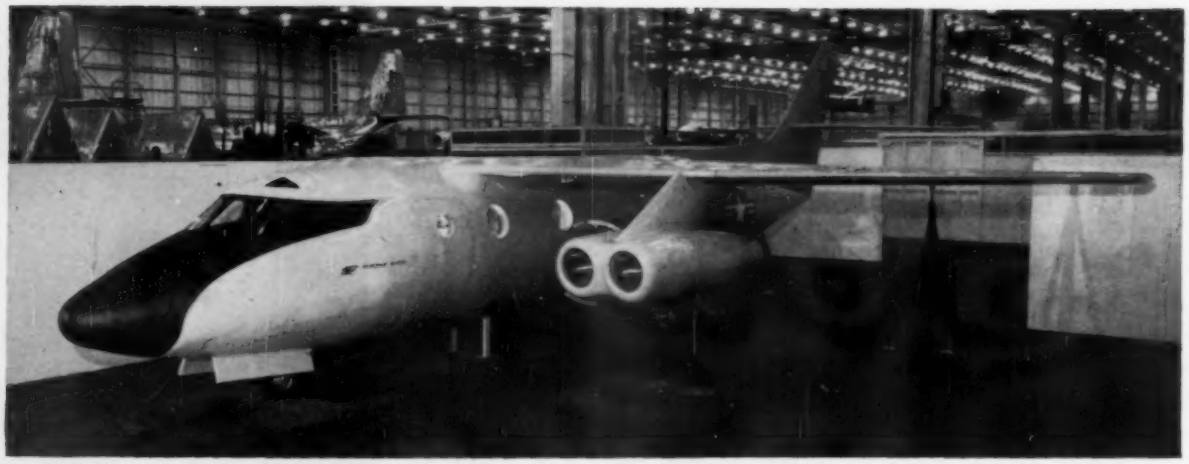
Send resume to

BILL WHITESIDES

Flight Refueling, Inc.

FRIENDSHIP AIRPORT

Baltimore 3, Maryland



FULL-SCALE MOCKUP of Fairchild M-185F jet transport is available for customer inspection at Hagerstown, Md. Long nose is designed to house radar. Passenger door is on left ahead of the wing. Main landing gear retracts into the side of the cabin.

Fairchild Sees Market for 600 M-185Fs

By Erwin J. Bulban

New York—A market of approximately 600 units exists for the new Fairchild M-185F four-jet eight-passenger business transport, according to Richard S. Boutelle, president of Fairchild Engine & Airplane Corp., Hagerstown, Md.

Boutelle said that this figure was developed during a market survey by the company aimed at finding out the sales potential for its new project. He expects that this potential will be reached within six years after delivery of the first M-185F.

Number one production M-185F will be delivered to Continental Can Co. sometime in 1960. The corporation has ordered three M-185Fs (AW Aug. 27, p. 33), in addition to a turboprop-powered Fairchild F.27 Friendship executive plane, which it expects to receive in July 1958.

Continental Can Co., which became the first corporation to sign a letter of intent to purchase jet transports, will get production airplanes numbers one, three and five. Fairchild will retain the experimental prototype for development and demonstration purposes. Continental will base the M-185Fs at its Morristown, N. J., operations and maintenance base. The company now has a fleet of five piston-engine executive planes: three Lockheed Lodestars, a Martin B-26 Marauder and a Convair LB-30 Liberator. It sets a target of 50 hr./month utilization per airplane and generally goes above that.

DISPLAY MODEL shows how wing leading edge is swept back about 25 deg., trailing edge about eight degrees. Extra fuel tanks will be hung between the engines and the wingtips.

Speed and Low Cost

Continental's quest for greater speeds to take advantage more effectively of executive productive capacity, estimated as worth thousands of dollars per hour, was indicated by company chairman Gen. Lucius D. Clay (ret.), who noted that the M-185F jets will be twice as fast as its current piston fleet. "Another important consideration is the cost factor . . . we estimate that the M-185F's operating cost will be about the same as one of our twin-engine Lodestars."

Addition of jet equipment will make the following schedules possible for company executives, according to Fairchild: New York to Chicago, 1 hr. 30 min.; New York to Miami, 2 hr. 20 min.; Chicago to Dallas, 1 hr. 40 min.; Dallas to Los Angeles, 2 hr. 40 min.; Los Angeles to Kansas City, 2 hr. 50 min.

Safety inherent in the four-engine layout was paramount in the thinking of Steve Brown, Continental chief pilot, who told AVIATION WEEK, the new jet will have a three-engine climb of 1,700

ft./min. to 3,000 ft./min., depending on loading. Ceiling of approximately 35,000 ft. can be maintained in event one of the turbojets flames out, he noted. Optimum operating altitude for the M-185F will be 45,000 ft., maintaining a cruise speed of about 470 kt. The M-185F is designed for a range of approximately 2,200 nautical miles at cruise setting taking into account a 70 mph. headwind and leaving 30 min. fuel reserve. Latter figures are based at sea level; at optimum altitude, the fuel reserve would come to about 45 min.

Continental's airplanes will be fitted with external auxiliary fuel tanks outboard of the engines giving a total of 1,800-1,900 gal.

Although a firm price was not disclosed for the executive M-185F, it is understood to be less than $1 million, minus certain equipment such as plug-in radio. A high Fairchild source estimated the company will break even on sales of less than 100 airplanes. It has spent approximately $2 million on development to date. An official estimates the program will cost about $6 million up to the first flight of the prototype. Fairchild is financing the venture privately, no military funds being used.

The company will borrow four Fairchild J83 jets with 50 hr. on them from USAF for prototype flying. These 2,-000-lb.-thrust-class engines are expected to be standard powerplant, although the General Electric J85, in approximately the same thrust class, may be substituted. Final powerplant decision will rest upon availability of engines in sufficient quantity and USAF's willingness to release them for civilian use. A Fairchild official noted that should J83s not be available in time for flight of the prototype, two Westinghouse J34s may be used to gain aerodynamic and flight data pending receipt of the specified engines. The prototype M-185F is expected to make its first flight late next year or early in 1958.

Performance Stretch

Considerable performance stretch is being built into the new Fairchild; an official estimates that within five years after the powerplants are certificated their thust ratings will be 50% higher than current power. Pod mounting also makes it possible to consider engines of larger dimensions than current powerplants. Previous M-185 configurations which had the engines mounted in the fuselage tail would have made this more difficult. Actually, the company went to underwing pods primarily because of customer resistance to buried powerplants. Continental expects that the M-185F's engines will be fitted with thrust reversers, and the landing roll performance is predicated on such an installation.

Detailed weight and performance data is not yet available, the company says, because of military security regarding the new J83 and J85 powerplants. The M-185F will span approximately 57 ft. and be about 56 ft. long.

Indications are that the plane will offer a brand new market to equipment makers, even with Fairchild studying ways and means of incorporating as much equipment as possible made by its various divisions, which specialize in air conditioning and pressurization.

Continential Chief Pilot Brown noted that his company has not yet made up a detailed specification of its equipment requirements in the airplane. "Most of the equipment will be new to us," he noted, "maybe some of it isn't even made yet." He pointed out that "you don't put piston-engine equipment in a jet airplane." For example, the company will obtain for its M-185Fs either the Sperry or Bendix autopilots similar to those going into the Boeing 707 and Douglas DC-8. It also plans to install Bendix C-Band weather radar.

Interior design and furnishings are other matters the corporation has not yet decided upon. Brown said that he expects to discuss these with Fairchild people soon.

All-Metal Polish Trainer Details Are Revealed

Vienna, Austria—First details to be disclosed on the new two-place Bies all-metal trainer, shown for the first time at the Poznan Fair, reveal that it has a 320-hp. engine and a top speed of 196 mph.

The Bies trainer closely resembles the North American T-28 in general configuration (AW July 9, p. 87). Gross weight is 3,410 lb. and range is about 435 mi. Rate of climb is reported to be 22.3 ft./sec. and ceiling as 19,685 ft.

The airplane is in quantity production. Equipment and other components are installed in sub-assemblies, which are later joined on a final assembly line.

Aeroflot Yak-12 Handles Light Utility Roles

Yak-12P, code-named Creek by NATO, is used by the Russians for a wide variety of utility duties including crop dusting, wolf-hunting and ambulance missions. This airplane bears the insignia of Aeroflot, Russian national airline, typifying the carrier's diverse operations. Among the plane's features are closely spaced vane-like shutters enclosing the front of the 145-hp. engine, probably to maintain proper temperatures in Arctic operations, full-span leading edge wing slats and long-span trailing edge flaps to permit flying in and out of small, unprepared fields.

EMPLOYMENT OPPORTUNITIES

The Advertisements in this section include all employment opportunities—executive, management, technical, selling, office, skilled, manual, etc.

Positions Vacant	Civil Service Opportunities	Employment Agencies
Positions Wanted	Selling Opportunities Wanted	Employment Services
Part Time Work	Selling Opportunities Offered	Labor Bureaus

DISPLAYED —RATES— **UNDISPLAYED**

The advertising rate is $27.60 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

An Advertising inch is measured ⅞" vertically on a column—3 columns—30 inches to a page.

Subject to Agency Commission.

$2.10 per line, minimum 3 lines. To figure advance payment count 5 average words as a line.
Position Wanted Ads are ½ of above rate.
Box Numbers—counts as 1 line.
Discount of 10% if full payment is made in advance for 4 consecutive insertions.
Not subject to Agency Commission.

Send NEW ADS to Classified Advertising Div. of AVIATION WEEK, P. O. Box 12, N. Y. 36, N. Y., for Sept. 17 issue closing Sept. 6

• AERODYNAMICS • ELECTRONICS • MISSILES • AIRCRAFT • NUCLEAR REACTORS • WEAPONS SYSTEMS • MATERIALS RESEARCH • CONTROL EQUIPMENT • ROCKET PROPULSION • THERMODYNAMICS • SERVO-MECHANISMS •

ENGINEERS SCIENTISTS

YOU . . . Will Have a Stronger Future,
. . . More Opportunity for Advancement,
. . . More Interesting Assignments,
. . . More Variety and Challenge.

YOU . . . Will Be a Member of the Top Team.
. . . Can Be Sure Your Company's
. . . Products Are the Best,

AND . . .

YOU . . . Only Live Once — As Long
. . . As You Have To Earn a Living . . .
. . . Why Not Enjoy It?

AT . . .

ATOMICS INTERNATIONAL . . . . (Canoga Park, California)
ROCKETDYNE . . . . . (Canoga Park, California)
AUTONETICS . . . . . (Downey, California)
AVIATION . . . . . (Los Angeles, California)
MISSILE DEVELOPMENT . . . . . (Downey, California)
AVIATION . . . . . (Columbus, Ohio)
MISSILE FLIGHT TEST . . . . . (Cocoa, Florida)

Divisions of North American Aviation, Inc.
For Your Opportunity of a Lifetime CONTACT

G. W. Benedict
North American Aviation, Inc.
19 Rector Street
New York, New York
Phone Digby 4-3970

PRIVATE LINES

Cessna recently previewed 1957 Model 172 four-place business plane to dealers and distributors at Wichita, Kan. Full-scale public showings of the new plane will be held on two successive weekends around the country on Sept. 29-30 and Oct. 6-7. Pattern of shows will follow successful promotion of Model 182 early this year (AW May 28, p. 100).

First civil deliveries of the new Bell 47J Ranger utility helicopter will begin early next year. Powered by a 260-hp. Lycoming VO435-21 engine derated to 220 hp., the 47J will operate 600 hr. between major overhauls, company officials report. Useful load is 1,017.5 lb., gross weight 2,565 lb. At this gross weight the Ranger will climb from sea level to 5,000 ft. in 7.5 min. Fuel supply of 35 gal. will provide a 175-mi. range. Ranger received Type Certificate 2H-1 from Civil Aeronautics Administration recently. Its U. S. Navy counterpart is the HUL-1. Price announcement is expected at an early date.

U. S. exports of business aircraft of 6,000 lb. and less in the first half of 1956 totaled 443 units valued at $5,238,792, a 25% increase over the first half of last year. June 1956 exports totaled 69 airplanes valued at $933,309—a drop from June 1955, when 83 units valued at $1,005,920 shipped abroad.

De Havilland Dove is being used by personnel of Orenda Engines, Ltd., Toronto, to visit RCAF bases to service the company's turbojet powerplants.

Winners of Aircraft Owners & Pilots Assn. nationwide membership contest: Donald G. Rhodes, Midvale, Utah, awarded a Champion Sky-Trac and William J. Meehan, Elon College, N. C., received a Piper Tri-Pacer. The contest brought AOPA membership to a total of almost 58,000.

No. 1,000 Cessna 172 was delivered to Ward and Ralph McDowell, Ft. Worth, Tex., businessmen, eight months after the plane was introduced.

Three-day study course for airport management personnel is scheduled for Oct. 3-5 at the University of Oklahoma. Sponsors are The American Association of Airport Executives and the university in cooperation with CAA.

New distributor for Temco-Riley Twin-Navion conversion is Van's Air Service, Winona, Minn., covering Minneapolis-St. Paul and neighboring area.

Stock Transactions

Disposal of 5,319 capital shares of Glenn L. Martin Company stock by George M. Bunker, officer and director of the company is reported by the Securities and Exchange Commission in its latest report. Mr. Bunker has a holding of 15,600 capital shares remaining.

Other transactions for the period May 11 to June 10 were:

Allegheny Airlines Inc. Acquisition of 1,000 common shares by Hugh R. Sharp, Jr., director, making a holding of 1,700.

American Airlines Inc. Disposal of 800 common shares by R. E. S. Deichler, officer, leaving a holding of 2,200.

American Electronics, Inc. Disposal of 400 common shares by Warren H. Crowell, director, leaving a direct holding of 4,050 and an indirect holding of 1,210.

Beech Aircraft Corp. Acquisition of 376 common shares by Frank E. Hedrick, officer, making a holding of 3,688.

Bell Aircraft Corp. Acquisition of 200 common shares by Harvey Gaylord, officer, making a holding of 1,200; acquisition of 100 common shares by Walter A. Yates, director, making a holding of 4,250.

Bendix Aviation Corp. Acquisition of 375 common shares by A. P. Fonatine, officer making a holding of 1,125; acquisition of 400 common shares by Henry A. Gossner, officer, making a holding of 900; acquisition of 700 common shares by William H. Houghton, officer and director, making a holding of 3,083.

Braniff Airways Inc. Disposal of 400 common shares by C. G. Adams, officer and director, leaving a holding of 10,759; acquisition of 300 common shares by Milton McGreevy, director, making a holding of 2,300.

California Eastern Aviation Inc. Disposal of 5,900 common shares by William W. Brinckerhoff, officer and director, leaving a holding of 82,999; disposal of 2,135 common shares by Edward A. Kerbs, director, leaving a direct holding of 5,870 and an indirect holding of 765.

Capital Airlines Inc. Disposal of 388 common shares by Hayes Dever, officer and director, leaving a holding of 2,500; disposal of 5,600 common shares by Charles H. Murchison, director, leaving a holding of 15,682; disposal of 250 common shares by Harold Byron Smith, director, leaving a holding of 1,028.

Cessna Aircraft Co. Acquisition of 290 common shares by Roy C. Russell, director, making a holding of 690.

Continental Aviation and Engineering Corp. Acquisition of 1,000 common shares by Carl F. Bachle, officer, making a holding of 1,550; acquisition of 1,000 common shares by James W. Kinnucan, officer, making a holding of 1,000.

Curtis-Wright Corp. Acquisition of 1,000 common shares through exercise of option by Sam D. Irwin, officer, making a holding of 1,200; acquisition of 700 common shares through exercise of option by Joseph V. Miccio, officer, making a holding of 2,800.

Emery Air Freight Corp. Acquisition of 100 common shares by Peter J. Byrne officer, making a holding of 950; acquisition of 800 common shares by Walter G. Corcoran, officer, making a holding of 1,214; acquisition of 1,000 common shares by John C. Emery, officer and director, making a holding of 11,000; acquisition of 500 common shares by John C. Emery, Jr., officer, making a holding of 1,600; acquisition of 200 common shares by A. M. McIver-Campbell, officer, making a holding of 1,200; acquisition of 600 common shares by Henry A. Pfaff, officer, making a holding of 1,700.

Flying Tiger Line Inc. Disposal of $3,000 of 5½% convertible debentures by George T. Cussen, officer, his total holding; disposal of $5,000 of 5½% convertible deben-

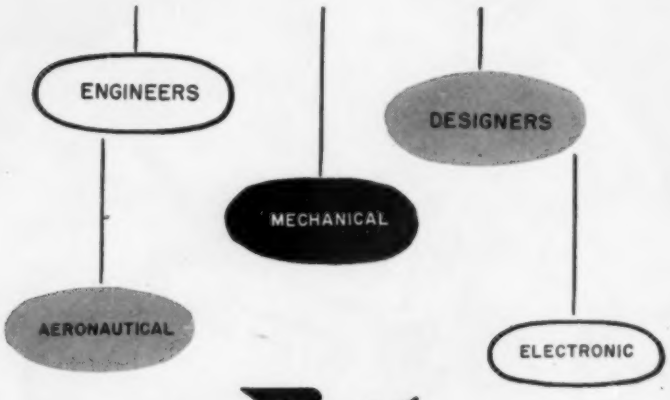
the sky is our world

From advanced research into the fundamental forces of the universe—gravity, nucleonics, astrophysics—to the launching of man's first stepping stones into space itself, Martin engineering activities are among the most exciting in the aircraft industry today.

The sky is our world, and outer space is the next frontier!

If you are interested in learning the story of a great engineering adventure, which includes some of the most advanced projects now in the research and development stage, contact J. M. Hollyday, Dept. AW-09, The Martin Company, Baltimore 3, Maryland.

MARTIN
BALTIMORE



Bendix

Provides MIDWEST Opportunities for Experienced Engineers

In South Bend, hundreds of professional people have found a community adequately satisfying for a highly educated way of life. Notre Dame is an excellent center for technical, graduate study, as well as affording cultural opportunities.

Immediate openings available in research, design, test and development:

AIRCRAFT JET FUEL SYSTEMS →
Electro-Mechanical Design
Magnetic Amplifiers
Nuclear Control Applications
Rocket Circuitry
Servo-Mechanisms
Systems Evaluation
Thermo-dynamics
Transistorization
Vibration Analysis

AIRCRAFT LANDING GEAR →
Computer Applications
Heat Transfer
Stress Analysis
Structure
Systems and Component Design or Testing

AUTOMOTIVE COMPONENTS →
Conventional Brakes
Hydraulic Systems
Mechanical Design and Test
Power Brake Research
Power Steering

If you are interested in any of these engineering projects, send a summary of education and experience to:

Technical Employment,
Department A-3,
BENDIX PRODUCTS DIVISION OF
BENDIX AVIATION CORPORATION
401 Bendix Drive
South Bend, Indiana

PERSONNEL MANAGERS

LOOKING FOR ENGINEERS . . . TECHNICIANS?

Write for free copy of

"RESERVOIR OF ENGINEERS AND TECHNICAL MEN"

It explains how you can pin point your employment advertisement to just those men with the job qualifications you want . . . without wasting money or superfluous circulation.

Classified Advertising Division — McGraw-Hill Publishing Co.
330 West 42nd Street, New York 36, New York

tures by Frank B. Lynott, officer, leaving a holding of $15,000.

General Dynamics Corp. Acquisition of 100 common shares by Sylvan C. Coleman, director, making a holding of 100; disposal of 200 common shares by Robert P. Meiklejohn, officer, leaving a holding of 6,010; disposal of 300 common shares by Reeve Schley, director, leaving a holding of 4,043 shares.

General Electric Co. Acquisition of 900 common shares by Thomas B. McCabe, director, making a holding of 2,500; disposal of 400 common shares by Gerald L. Phillippe, officer, leaving a holding of 3,177; acquisition of 3,450 common shares by Charles K. Rieger, officer, making a holding of 3,456 shares.

General Motors Corp. Disposal of 500 common shares by Richard C. Gerstenberg, officer, leaving a holding of 3,769; disposal of 400 common shares by Gerald L. Hogan, officer, leaving a holding of 23,507; disposal of 1,000 common shares by Cyrus R. Osborn, officer and director, leaving a direct holding of 19,901 and an indirect holding of 322.

Minneapolis-Honeywell Regulator Co. Disposal of 500 common shares by C. B. Sweatt, officer, leaving a direct holding of 76,520 and an indirect holding of 9,230; disposal of 1,800 common shares by H. W. Sweatt, officer and director, leaving a direct holding of 85,690 and an indirect holding of 7,200; disposal of 1,200 common shares by John J. Wilson, officer and director, leaving a holding of 87,800; acquisition of 150 common shares by P. B. Wishart, officer and director making a holding of 4,370.

National Airlines Inc. Acquisition of 100 common shares by Edwin C. McDonald, director, making a holding of 700.

National Aviation Corp. Acquisition of 210 common shares by Frederick F. Robinson, officer, making a holding of 710; acquisition of 385 common shares by Marjorie E. Tindall, officer, her total holding; acquisition of 243 and disposal of 500 common shares by Elmer Wellin, director, leaving a holding of 5,043.

Pacific Northern Airlines. Acquisition of 1,600 common shares by Dean B. Hart, officer, making a holding of 8,000; acquisition of 500 common shares by Robert A. Rowan, director, making a holding of 19,067.

Philco Corp. Disposal of 1,300 common shares by James B. Buckley, director, leaving a holding of 9,551; disposal of 17,700 common shares by James H. Carmine, director, leaving a holding of 13,738; disposal of 300 common shares by Raymond B. George, officer, his total holding; disposal of 900 common shares by Joseph H. Gillies, officer, leaving a holding of 5,827; acquisition of 1,000 common shares by Russell L. Heberling, officer, making a holding of 5,515; acquisition of 1,000 common shares by John M. Otter, officer and director, making a holding of 6,577; disposal of 500 common shares by R. A. Rich, officer, leaving a holding of 25; acquisition of 1,000 common shares by James M. Skinner, Jr., officer, making a holding of 9,670; acquisition of 200 common shares by William R. Wilson, officer, making a holding of 15,200; disposal of 200 common shares by Leslie J. Woods, officer and director, leaving a holding of 7,373.

Trans Caribbean Airways. Disposal of 3,175 class A common shares by O. Roy Chalk, officer and director, leaving a holding of 31,234.

Trans World Airlines Inc. Acquisition of 62 and disposal of 150 common shares by John L. Weller, officer, leaving a holding of 22.

United Air Lines Inc. Disposal of 100 common shares by R. F. Ahrens, officer, leaving a holding of 2,902; disposal of 300 common shares by R. E. Johnson, officer, leaving a holding of 2,700.

United Aircraft Corp. Acquisition of 147 common shares by Carroll L. Gault, officer, making a holding of 1,827; disposal of 84 preference shares by Carroll L. Gault, officer, his total holding.

Western Air Lines Inc. Disposal of 200 capital shares by G. G. Brooder, officer, leaving a holding of 1,800; acquisition of 200 capital shares by L. Welch Pogue, director, making a holding of 1,050.

Here's one **for you**

Inside this folder is a problem. It may be on missiles, on plastics, on structures, on electronics, on any of the diverse fields of engineering for which Goodyear Aircraft is renowned. Whatever it is, you can be sure it represents a real and important engineering challenge.

If you are a creative engineer, with faith in your ideas and confidence in your ability to make them work, *this* may be the challenge *you* have been seeking. For, due to our growth and diversification, we find it necessary to expand our engineering staffs at both Akron, Ohio, and Litchfield Park, Arizona. Opportunities are unlimited for rewarding professional careers in all specialties of engineering.

And, we mean *careers*—not just *jobs*. For here, your imagination and ingenuity are our raw materials. Here, your every idea has a chance. And, in transforming your ideas into practical realities, you will discover the exciting stimulation of creative challenge leading to a real satisfaction of accomplishment.

At Goodyear Aircraft you will discover a diversification rarely found under one roof. Whatever your specialty, you will find opportunities in every phase of aviation—civil and military.

Salaries and benefits are, of course, liberal. And, if you wish to continue your academic studies, company-paid tuition courses leading to advanced degrees are available at nearby colleges.

For further information on *your* career opportunities at Goodyear Aircraft, write: Mr. C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio.

They're doing big things at

GOODYEAR AIRCRAFT

THE TEAM TO TEAM WITH in AERONAUTICS

ENGINEERS, SCIENTISTS, DESIGNERS

Outstanding Opportunities Available

The types of work on which you could be engaged include:

Missiles
Applied Mechanics
Geophysics
Underwater Ordnance
Electronic Countermeasures
Digital & Analog Computers
Instruments and Controls
Solid State Physics
Microwaves & Antennas
Infra Red Systems
Inertial Systems
Servomechanisms
Balloon Systems
Industrial Automation
Upper Atmosphere Research
Fine Particle Technology
Surface Chemistry
Optics
Mechanical Design
Airborne Early Warning
Radar Systems
Information Theory

Systems Analysis and Design
Electronic Equipment Design and Miniaturization

You can grow with our dynamic and progressive research and development activity in its long-term expansion. We are prime systems contractor for several major programs in which new groups are being formed and which create ground floor opportunities for you. We have excellent facilities and equipment and can use people to the fullest extent of their capacity, with encouragement and opportunity to advance further. You can work closely with prominent engineers and scientists. Our managerial positions are staffed by people with technical engineering backgrounds. You do not become isolated on a small part or component but contribute to and become an integral part of a significant program. Congenial associates and atmosphere. Our people tell us they **enjoy** their work, and our extremely low turnover rate testifies to this. Tuition re-imbursement plan includes University of Minnesota three minutes away. Delightful residential communities close to work, fine cultural environment, recreational areas, fishing, hunting, boating, winter and summer sports. Live in the Land of Sky Blue Waters. Permanent security with a stable, long-established company whose motto is "The Future is Our Frontier." Salaries recognize experience for all levels of positions. Relocation expenses. We believe we have all the opportunities you could find anywhere in the country.

Engineers—Electronic, Electrical, Aeronautical, Mechanical, Chemical
Physicists, Meteorologists, Physical and Electro *Chemists*
Junior, Associate, and *Senior* grades, from Bachelor through Doctorate degrees.

All inquiries will be treated in complete confidence.

You are invited to address **PETER BURGESS,** *Director of Personnel,*

Mechanical Division of General Mills, Inc.,
1620 Central Ave. N.E., Minneapolis 13, Minnesota.

GAMBLE?

sure . . . if the odds are in YOUR favor . . .

DECISION/INC—nationwide specialists in recruitment of engineering personnel—have an active and enviable record in developing job opportunities for men who want bigger salaries and a chance for greater personal achievement.

DECISION/INC is retained by more top-ranking firms thruout the nation than any other organization to *find the right man* for each job. This confidential service costs you nothing.

It takes TIME—MONEY—EFFORT to improve your job situation. If you are an engineer or scientist, particularly in the ELECTRONIC—AERO-NAUTICAL or GUIDED-MISSILE field, DECISION/INC will do this **quickly, effectively at no cost to you.**

HOW? Our placement specialist develops a plan "tailor-made" for you —which includes a resume of your experience . . . and then a review by selected companies leading to confidential interviews at **your** convenience and **our** client's expense.

NOW is the time for DECISION!
All **you** do **Now** is . . . send us your name, home address, job interest or title. We take it from there.

Write or phone:
OLIVER P. BARDES,
President—
DECISION/INC
1460-8 FIRST NATIONAL BANK BLDG.
CINCINNATI 2, OHIO
GArfield 1-1700

Publishers of the authoritative Engineers' Job Directory

HERE'S WHAT YOU CAN LOOK FORWARD TO AS A . . .

FLIGHT ENGINEER

WITH

TWA

- **A Career with a Future**
- **Retirement Plan**
- **Annual Sick Leave**
- **Paid Vacation**
- **Group Insurance**
- **Liberal Free Transportation for You and Your Family Each Year**

Yes, here is a career opportunity with a real future! You not only get all of these, and many more, benefits as a TWA Flight Engineer—you start out at $330 per month as a student—$485 per month as a Flight Engineer plus regular future salary increases. Beginning with the third year, Flight Engineers receive monthly base pay and guarantee of 60 hours of flight pay.

Here are the qualifications: Between the ages of 23 to 35; normally 5'7" to 6'2" inclusive; high school diploma or equivalent; pass CAA Class II physical (no waivers). Technical qualifications include: Broad A&E experience and must have CAA A&E Licenses before entering training class; pass examinations for student flight engineer.

There's a wonderful future waiting for you with TWA. Write today to Mr. R. Paul Day, Employment Manager.

TRANS WORLD AIRLINES
MUNICIPAL AIRPORT
KANSAS CITY, MO.

FLUTTER and VIBRATION GROUP ENGINEER

Will be responsible for flutter and vibration control of high speed airplane weapons system. Requires a working knowledge of theoretical flutter analysis of high speed aircraft, flight flutter testing, flutter model testing, and vibration theory and testing.

If qualified, send detailed experience resume to:

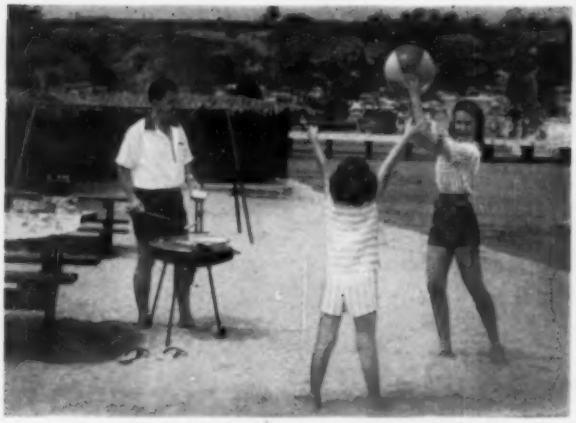
R. F. Kaletta
Technical Placement Supervisor
P. O. Box 516
St. Louis 3, Missouri

MC DONNELL AIRCRAFT CORPORATION

An employment advertisement in this EMPLOYMENT OPPORTUNITIES section will help you find the engineers you need. It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the Aviation field.

ENGINEERS

LIVE BETTER AND ACHIEVE MORE IN SUNNY SAN DIEGO!



In San Diego you're only minutes from desert, mountains, oceans, bays, other attractions.

San Diego's year-round outdoor living makes it the finest place in the world to raise your family.

Solar offers challenging opportunities for engineers in the fields of gas turbine engines, airborne controls and advanced aircraft and missile components

THREE GREAT ADVANTAGES are yours when you join Solar's Engineering Division. You'll live in attractive San Diego. You'll work on advanced development and production projects that will utilize your best abilities. And you'll be working for a medium-size company—one where you get broader engineering experience than in larger firms, and where achievement is given quick recognition.

Solar's enlightened personnel policies provide a complete range of liberal benefits, including a profit sharing retirement plan. The Engineering Division has never terminated an engineer for lack of work. Extremely low turnover shows that engineers like Solar as a place to settle down for long range *careers.*

We'd like to tell you more about working for Solar, and living in San Diego. If you're looking for an exceptional opportunity, please send a brief outline of your qualifications, including educational background, to Dale A. Cobb, Dept. E-109, Solar Aircraft Company, 2200 Pacific Highway, San Diego 12, California.

Solar's engineers get broad engineering experience, intimate knowledge of Solar's products.

SOLAR HAS PERMANENT OPENINGS FOR

Project Engineers—Gas Turbine Development
Project Engineer—Pneumatic Ducting Systems
Chief of Engineering Test
Combustion Engineers—Gas Turbines
Specifications Engineer • Experimental Engineers
Design Engineers
Designers • Checkers • Draftsmen

SOLAR
AIRCRAFT COMPANY

SAN DIEGO
DES MOINES

DESIGNERS, DEVELOPERS AND MANUFACTURERS • GAS TURBINES • AIRCRAFT AND MISSILE COMPONENTS • BELLOWS • CONTROLS • COATINGS • METAL ALLOY PRODUCTS

AVCO makes 18,000 m.p.h. stand still

Actual shock wave photographed through viewing port in Avco's Hypersonic Shock Tube

To speed development of an advanced Air Force missile system

The Hypersonic Shock Tube, developed by Avco scientists and engineers, has provided an accurate "testing ground" in the search for metallic materials and aeronautical designs which will withstand the heat created by 18,000 m.p.h. speeds. The effect of such hypersonic speeds can now be observed and recorded on a stationary model in the laboratory.

Already, findings of tests carried out in the "shock tube" have proven to be valuable contributions to the technology of advanced missile systems.

New frontiers in research have thereby been opened, which will lead to many exciting new careers.

EXCITING NEW CAREERS

for forward-looking scientists and engineers. Avco's long-range expansion—in missiles and all the physical sciences—offers unprecedented opportunity.

Physical Scientists: Advanced degree preferred in—Physics — Aerodynamics — Electronics — Metallurgy — Physical Chemistry — Mathematics

Engineers: Electronic — Mechanical — Aeronautical — Chemical

WRITE: Dr. Lloyd P. Smith, President, Avco Research and Advanced Development Division, Stratford, Conn., or phone Bridgeport, Conn., Drexel 8-0431

avco

avco Research and Advanced Development division

avco defense and industrial products

combine the scientific skills, and production facilities of 3 great divisions of Avco Manufacturing Corp.: Research and Advanced Development, Crosley, Lycoming—which currently produce power plants, electronics, airframe components, and precision parts.

PLANT MANAGER

To operate new plant now being built in Ogden, Utah to manufacture ramjet engines for guided missiles. Must have production and overall plant management experience. Engineering Degree desirable but not mandatory. Excellent opportunity in rapidly growing vigorous young company. Forward complete background of education, experience and compensation. Personal attention Executive Vice President.

marquardt AIRCRAFT CO.

P. O. Box 2013, Van Nuys, California

WANTED

PRESIDENT

—for multi-million dollar company manufacturing aircraft parts and assemblies.

MUST BE

—a leader of proven ability to assume complete responsibility for manufacturing, sales, and profits; this is an immediate, not an "eventual", opportunity.

—a forward planner capable of utilizing exceptional physical, engineering, and financial resources in the development and implementation of profitable programs in new or expanded fields.

—well and favorably known in high aviation circles.

COMPENSATION

—will be discussed personally with qualified candidates. The man we seek likely can command combined salary and incentive earnings approaching six figures.

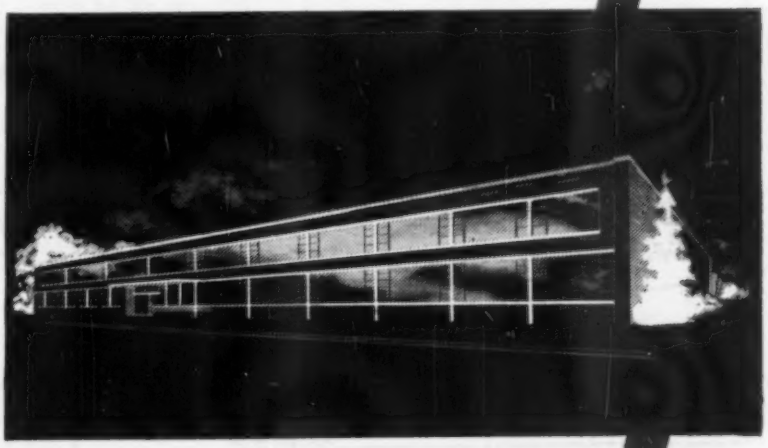
REPLIES HELD IN ABSOLUTE CONFIDENCE
Client executives know of this opening.

Address: Management Consultant
P-2870, Aviation Week
Classified Adv. Div., P.O. Box 12,
New York 36, N. Y.

ENGINEERS
SCIENTISTS

GROW WITH REPUBLIC'S GUIDED MISSILES DIVISION ON LONG ISLAND

Ground floor advancement opportunities for you as we double our facilities and working areas. Enjoy mild 4-season weather on this eastern playground.



We seek engineers with missile experience, or specialists now employed in allied fields. Republic's Guided Missiles Division specializes in research and development work. Of the several "hush-hush" projects now being developed, one is substantially more advanced than the earth satellite being launched into outer space next year.

Openings now in:
WEAPONS SYSTEMS ANALYSIS • AERODYNAMICS
OPERATIONS RESEARCH • PRELIMINARY DESIGN

Enjoy working on Long Island in our brand-new, modern, air conditioned, 2-story office building designed for engineers.

Please forward complete resume to
Administrative Engineer, Mr. R. R. Reissig

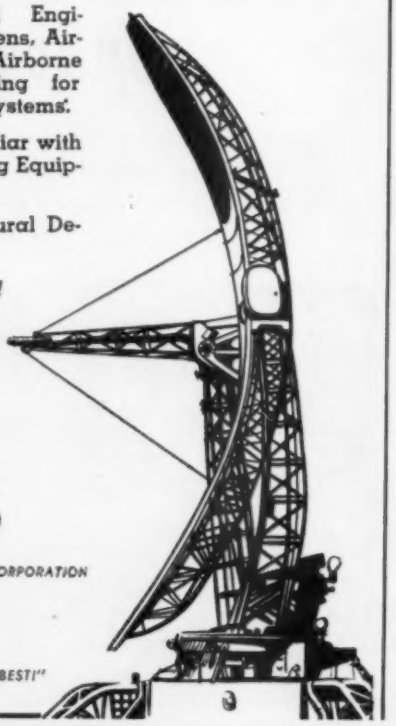
GUIDED MISSILES DIVISION
REPUBLIC AVIATION
233 Jericho Turnpike • Mineola, L. I., N. Y.

STRUCTURAL ENGINEERS

A new and important era is dawning at CROSLEY! Here are career opportunities that offer almost unlimited scope and endeavor for projects that stir the creative imagination.

There are needs in these current fields of CROSLEY activity:

1. Experienced Aeronautical Engineers to design Radar Screens, Aircraft Turrets, Missile and Airborne Aircraft Airframes, Housing for Radar and Fire Control Systems.
2. Mechanical Engineers familiar with Radar Antenna and Rotating Equipment Design.
3. Civil Engineers with Structural Design background.



Get the CROSLEY story TODAY!

Please Send A Written Resume To:
D. B. Nason
Vice President and Director of Engineering
Dept. T-7

Crosley DIVISION
AVCO MANUFACTURING CORPORATION

2630 Glendale-Milford Road
Evendale, Cincinnati 15, Ohio

"Known for the NEWEST — Respected for the BEST!"

TEST ENGINEERS

DO YOU LIKE YOUR ENVIRONMENT?

Investigate the Environment created at AC for its Advanced Development Programs on Missile Guidance and Aircraft Fire Control Systems.

OUR ENVIRONMENTAL LABORATORY

is one of the most Versatile Laboratories in the country and is in the process of a Major, Permanent Expansion. Men hired will enjoy working with the finest of test equipment and facilities, together with top men of the field.

We are currently engaged in the following Types of Test Activities:

VIBRATION TESTING
COMPLEX WAVE ANALYSIS
LOW TEMPERATURE - ALTITUDE
HIGH TEMPERATURE
RELIABILITY EVALUATION
INSTRUMENTATION

Write Mr. J. Heffinger
Supervisor of Salaried Personnel

AC
The Electronics Div.
General Motors Corp.
Milwaukee 2, Wis.

SALES LIAISON REPRESENTATIVES

Servomechanisms Inc. Western Division, manufacturers of electronic components & sub-systems is expanding its liaison staff.

Challenging positions are now open to men with an E.E. Degree or equivalent engineering background and technical sales experience.

Attractive Salary & expense arrangements.
All replies will be held in confidence.
Please send resume to Philip Earl

SERVOmechaNISMS INC.

12500 AVIATION BOULEVARD
HAWTHORNE, CALIFORNIA

VTOL

AERONAUTICAL ENGINEERS

Unusually interesting design and development positions available in:

AERODYNAMICS
STRUCTURAL DESIGN
STRESS ANALYSIS
MECHANICAL DESIGN
ENGINEERING DRAFTSMAN

For immediate work on New Prime V T O L Aircraft Development Program.

Send resume to
DOAK AIRCRAFT CO., INC.
22309 So. Western Ave., Torrance, Calif.
Attn: Mr. N. E. Nelson, Chief Engineer

DOAK AIRCRAFT CO., INC.

ENGINEERS

If you have been looking for an Employment Agency that is skilled in the **STATE OF THE ART** of Technical Recruitment and **RELIABILITY OF INFORMATION** concerning positions, why not communicate with us at once!

FIDELITY PERSONNEL SERVICE
1218 Chestnut St. Phila. 7, Pa.
Specialists in Aviation and Electronics

EXPANDING HELICOPTER PASSENGER PROGRAM HAS OPENINGS FOR:

- **Passenger Reservations Personnel**
- **Supervising Accountant and Auditor Statistician**

Airline Experience Required. Address Reply To:

LOS ANGELES AIRWAYS, INC.
Box 45155, Airport Station,
Los Angeles 45, California

WANTED

Aero-Commander distributor wants Instrument Shop Foreman to supervise Certified Shop in fastest growing Corporate Aviation Company in the country. Company located in Midwest. Send resume to

P-2823, Aviation Week
520 N. Michigan Ave., Chicago 11, Ill.

Mechanical Engineers

Aircraft Gas TURBINE SPECIALIST

This is your chance to enjoy the exceptional professional advantages of a key position in advanced engine development—plus the personal benefits that are available to engineers — at General Electric's Jet & Rocket Engine Center.

Your qualifications should include a BSME degree and eight years of mechanical design experience on aircraft Jet engines, particularly in turbine design.

You will provide—technical guidance on engineering programs to assure technical adequacy of turbine design—advanced analytical and experimental procedures for analysis of turbine design problems —technical interpretation of analytical and experimental data in terms of effect on turbine design—and an ideal career for yourself.

Please write in confidence to:

Mr. Mark Peters, Dept. M-16
Technical Personnel, Bldg. 100
Aircraft Gas Turbine Division

GENERAL ELECTRIC

Cincinnati 15, Ohio

Engineers! Scientists!

Is your advancement keeping pace with your ability?

TCC

If you are not pleased with your present position . . . if you just don't seem to be doing the type of work you like to do . . . then we suggest you contact us at once.

We represent clients who retain us to secure qualified technical personnel for their ever expanding research and engineering programs. TCC can help you find the position that will utilize your abilities to the utmost . . . as well as satisfy your salary requirements and location preference.

Our service is completely confidential with all contacts being made at your residence. There is no expense or obligation to you whatsoever.

Write, phone, or wire today for information which will put you "on your way" to the position of your choice.

TECHNICAL CAREER CONSULTANTS
625 Tri-State Building
432 Walnut St., Cincinnati 2, Ohio
Attention: ROBERT ADAMS

engineers . . . physicists

NEW opportunities at Motorola in Riverside CALIFORNIA

WORK IN A VACATIONLAND

(your family will love year-round outdoor living)

WHILE YOU ADVANCE YOUR CAREER

This new Motorola Research Laboratory is expanding—creating outstanding career opportunities for engineers, working on military research and development principally related to guided missiles and weapons systems. You'll enjoy working in air conditioned comfort and well instrumented laboratories ... with liberal employee benefits, including an attractive profit sharing plan.

Here in relaxing Riverside you'll find planned communities, with modern shopping centers, advanced schools, and many fine buys in homes available (moving and travelling expenses paid for family). Living will be easier and more fun in Riverside, where there's more room to grow.

MOTOROLA IN RIVERSIDE HAS OPENINGS FOR:
Electronic Engineers, Mechanical Engineers, Physicists and Mathematicians.

Research Laboratory

- **Military Operation Analysis**
- **Analog Computer Flight Simulation**
- **Digital Computer Analysis**
- **Digital Computer Design**
- **Dynamics Analysis**
- **Microwave Systems**
- **Missile Systems**
- **Circuit Design**
- **Servo Mechanisms**
- **Aerophysics**

for above positions write to:
Mr. C. Koziol
Dept. G
8330 Indiana Ave., Riverside, Calif.

Excellent opportunities in PHOENIX and CHICAGO

OPENINGS IN PHOENIX

Electronic Engineers, Mechanical Engineers, Physicists, Metallurgists & Chemists.

RESEARCH LABORATORY

Microwave Antennas
Pulse and Video Circuitry
Radar Systems Design
Circuit Design
Electro-Mechanical Devices
Systems Test
Transistor Applications

For above positions write:
Mr. C. Coulter
Dept. G
3102 N. 56th St.,
Phoenix, Ariz.

SEMI-CONDUCTOR DIVISION

Transistor Application
Transistor Devices
Solid State Physics
Physical Chemistry
Metallurgical Engineering
Production Engineering

For above positions write:
Mr. V. Sorensen
Dept. G
5005 E. McDowell Rd.,
Phoenix, Ariz.

OPENINGS IN CHICAGO

Challenging positions in Two-Way Communications, Microwave, Radar and Military equipment, Television (Color), Radio Engineering and Field Engineering.

For above positions write:
Mr. L. B. Wrenn
Dept. G
4501 Augusta Blvd.
Chicago 51, Ill.

MOTOROLA

ENGINEERS

ARMA announces

INERTIAL NAVIGATION

development program for an advanced Air Force missile

Inertial Navigation offers the most advanced concept in guidance, requiring no terrestrial source of energy or information, no earth-bound direction once the ultimate destination is selected. It offers the most promising solution of the guidance problem for the long-range missile.

While the principles are simple, the realization involves advanced creative engineering. ARMA's many successes in the creation of precision instruments and systems for navigation and fire control, especially precision gyroscopic reference systems for all applications, fit it uniquely for a major role in this advanced area.

The height of imaginative resourcefulness and engineering skill are required to create the degree of precision—hitherto unattained—in the components essential to the guidance of advanced missile systems—the gyros, accelerometers, and computer elements. Miniaturization must be coupled with extraordinary ability to provide utmost accuracy under conditions of extreme velocities, temperatures, and accelerations.

There's significant scientific progress to be achieved at this leadership company and individual renown to be won, by engineers associated with ARMA's Inertial Navigation Program. Many supplementary benefits make a career here doubly attractive.
Moving allowances arranged.

Immediate openings for Supervisory and Staff positions as well as for Senior Engineers, Engineers, and Associate Engineers, experienced in:

Systems Evaluation
Gyroscopics
Digital Computers
Accelerometers
Telemetry
Guidance Systems
Reliability
Stabilizing Devices
Servomechanisms
Automatic Controls
Thermodynamics
Environmental Research
Transformers
Production Test Equipment
Standards

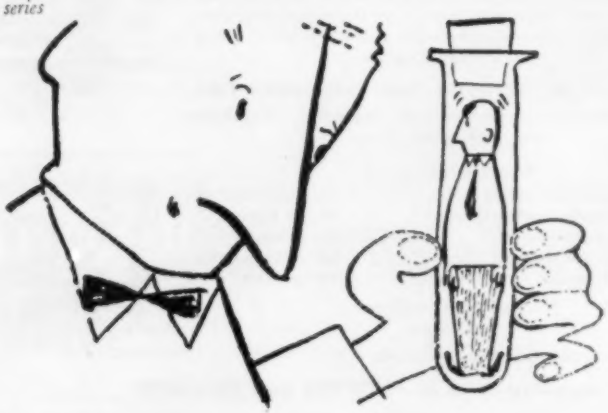
Forward confidential resume.
No reference contact without your permission.

Manager of Technical Personnel, Dept. 674

ARMA

Division of American Bosch Arma Corporation
Roosevelt Field, Garden City, Long Island, N. Y.

#3 of a series



There's a better way to get into research!

TEAM UP WITH ALLIED RESEARCH

We wouldn't recommend the unorthodox means our little peasant-under-glass has chosen to get into research. Especially when you can team up with ALLIED RESEARCH where research is both Pure and Unsullied or Applied and Down-to-Earth . . . and Rewarding too. **Write Today** to D. J. Fink.

ALLIED RESEARCH ASSOCIATES, INC.
43 Leon Street Boston, Mass.

Opportunities in these expanding fields: *Theoretical and applied aerodynamics — Stability and control — Aeroelasticity — Thermo-elasticity — Vibrations analysis — Mechanical Design — Applied mechanics — Aircraft and guided missile studies — Weapons effects — High temperature physics — Spectroscopy — Instrumentation — Radiation transfer*

LIAISON ENGINEER
for
MICROWAVE SYSTEMS

Opportunity with LIGHT MILITARY ELECTRONIC EQUIPMENT DEPARTMENT of GENERAL ELECTRIC

Capable of directing and coordinating the design and development of microwave projects on military airborne electronic systems.

SALARY TO $11,000
commensurate with experience

Reply in confidence to:
Mr. John Sternberg
Light Military
Electronic Equipment Dept.

GENERAL ELECTRIC

French Road Utica, N. Y.

REPLIES (Box No.): Address to office nearest you c/o This publication Classified Adv. Div.
NEW YORK: P. O. Box 12 (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)
LOS ANGELES: 1125 W. 6th St. (17)

POSITIONS VACANT

Analysts—Traffic & Economics. Executive offices in eastern city. Age 25-35 preferred. P-1155, Aviation Week.

Wanted—Aero-Commander distributor wants Instrument Shop Foreman to supervise Certified shop in fastest growing corporate aviation company in the country. Company located in Midwest. Send resume to P-2788, Aviation Week.

Experienced A & E Mechanic who has qualifications for CAA factory inspection authorization. Must be prepared to live in Italy. Basic contract for twelve months with possible renewal. C 46 experienced desired. Send detailed resume including picture and what foreign languages spoken to P-2840, Aviation Week.

Miami, Fla.—Aerodynamicists, Stress Analyst and Draftsman for 3 desirable positions in expanding Aeronautical Engineering School. Requires MS & 7 years aircraft experience. Salary to $10,000 for superior men under 35. Year round employment, 35 hour week, 4 weeks paid vacation. Send resume to Robert M. Williams, Director of Engineering, Embry Riddle School of Aviation.

POSITIONS WANTED

Competent Pilot, age 30 (3000 hrs) European and American background, interested in import and export sales, or any aviation position with a future. Speaks fluent Dutch, German, Flemish, French. PW-2778, Aviation Week.

Air Force contracts can be obtained for you by experienced Dayton representative. PW-2792, Aviation Week.

Do You Have a challenging opportunity for a top engineering executive with 32 years broad experience in the electronics, guided missile and major R & D programs with emphasis on system concepts? I am interested in making a change to a position where broad operating responsibilities are delegated; where personal ability as a lecturer and high level salesmanship will be utilized and an asset to the job. PW-2821, Aviation Week.

Airline Pilot. Fly your plane anywhere in world while on Oct. vacation. ATR, Fl. Nav. Lic. Exp. S. America, Europe, Africa. PW-2839, Aviation Week.

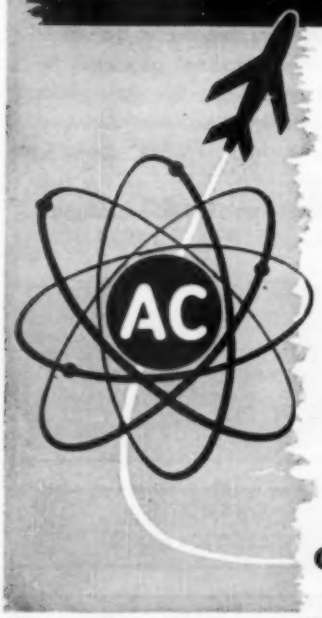
Inspector Mechanic—20 years aircraft experience overhaul, modifications, maintenance, repairs. Airline, A&E. PW-2834, Aviation Week.

Overseas—Pilot requires post outside U.S.A., hope permanency. 10 years' experience business flying, four continents, mostly tropics. British, 30, married, no children, very adaptable. British Altp, flight radio, licenses: dove, DC-3 ratings, 8,500 hours total. Willing convert licenses, nationality. Interview Europe—Skingley, c/o Guild of Air Pilots, London, England.

Pilot, ATR written, age 32, family, 4600 hours, 4 years executive DC-3, Twin-Beech, Mallard, desire captain position, state details first letter. PW-2860, Aviation Week.

ENGINEERS and DESIGNERS NEEDED

for: MISSILE GUIDANCE SYSTEMS · BOMBING NAVIGATIONAL COMPUTER SYSTEMS · NEW CIVIL AVIATION PRODUCTS · JET AND TURBO-PROP ENGINE CONTROLS · AIRBORNE FIRE CONTROLS



GM CAREER OPPORTUNITIES IN

Systems Engineering and Analysis
Experimental Engineering
Development Engineering
Project Coordination
Design Engineering
Product Engineering
Product Evaluation
Field Engineering

AND WE ALSO NEED:

DESIGNERS • CHECKERS • LAYOUT MEN

Positions Are Permanent — Excellent Advancement Opportunities

Every inquiry treated confidentially and given immediate attention and personal reply.

WRITE TODAY FOR EMPLOYMENT APPLICATION

Mr. John F. Heffinger
Supervisor of Salaried Personnel

AC SPARK PLUG DIVISION
THE ELECTRONICS DIVISION

GENERAL MOTORS CORPORATION

Milwaukee 2, Wisconsin — Flint 2, Michigan

Mechanical Engineer

WEIGHT CONTROL ENGINEER

This is your chance to enjoy the exceptional professional and personal advantages of a key position at General Electric's renowned Jet & Rocket Engine Center.

Your qualifications should include a BSME degree, 3 years in design of sheet metal or machined parts, and experience in aircraft or engine weight control and aircraft gas turbine engines.

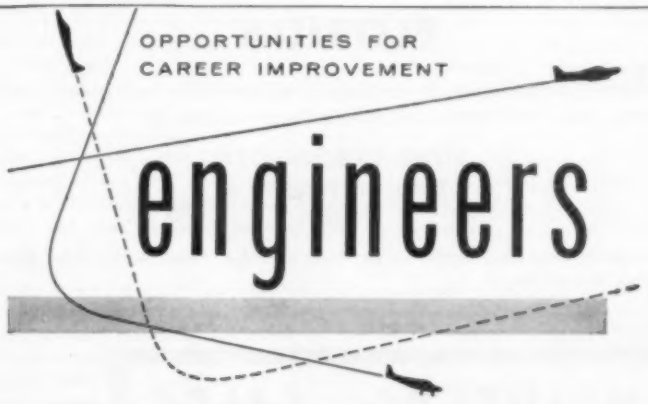
You will carry out an engine weight-control program: determining all data on weight, center of gravity, moments of inertia and loads; measuring Project Performance in meeting weight objectives; and promoting lightweight design throughout the Project. You will advance your career—at General Electric's Aircraft Gas Turbine Division.

Please send resume in confidence to

Mr. Mark Peters, Dept. M-12
Technical Personnel, Bldg. 100
Aircraft Gas Turbine Division
GENERAL ELECTRIC
Cincinnati 15, Ohio

OPPORTUNITIES FOR CAREER IMPROVEMENT

engineers



Cessna's continuous planned expansion provides greater potential for security in your future as an experienced engineer. Commercial aviation's "New Concept"... Business Flying, offers new horizons for the engineer at Cessna. A balance of military and commercial projects provide diversification of assignments and unlimited opportunities for advancement and recognition. Join Cessna and grow with Cessna.

STRUCTURES ENGINEERS—Assignments in:

- ☆ Aircraft component load determination ☆ Structural preliminary design analysis
- ☆ Airframe component stress analysis ☆ Airframe static test analysis
- ☆ Complete in-flight air-load survey programs
- ☆ Programming complex and detailed problems for our digital computer.

For comprehensive information write: Professional Placement Supervisor, Department AW

Cessna AIRCRAFT COMPANY

5800 EAST PAWNEE • WICHITA, KANSAS

engineers

CONTROLS ENGINEERS

are

KEY MEN

at the

Small Aircraft

Engine Dept. of G.E.

A most important element of engine design is harnessing the power to bring the aircraft home safely. This puts a Controls Engineer in a key spot.

Now unique opportunities exist for talented men to develop controls for new product line of advanced small turboshaft, turboprop and turbojet engines.

In: ENGINE CONTROLS DEVELOPMENT

SYSTEMS DESIGN: responsibility design and develop advanced systems—performance requirements—schematic diagrams—component and test specifications.

COMPONENT DESIGN: design, develop and package specific control components (sensors, actuators, fuel flow components, etc.)

EVALUATION: determine control test facilities. Direct component and systems testing. Correlate test data. Evaluate test results. Make recommendations to design groups.

ANALYSIS: determine engine control parameters. Prepare systems. Block diagrams. Analyze controls stability. Provide performance specifications (systems and components).

RELOCATION EXPENSES PAID

Please write in strict confidence to:

Mr. T. S. Woerz (Section 1-B-1)

SMALL AIRCRAFT ENGINE DEPARTMENT

GENERAL ELECTRIC

1000 Western Avenue, West Lynn, Mass.

PROJECT ENGINEERS

Opportunities in FLORIDA

Heavy experience in airborne electronics, computers and testing instrumentation required. Send resume to

VITRO LABORATORIES
Eglin Air Force Base
Florida

Opportunities also available at West Orange, New Jersey, and Silver Spring, Maryland.

ENGINEERS—SALES

Successful medium sized manufacturer of electronic components & sub-systems is expanding its customer liaison Staff.

Challenging positions are available to high caliber men with E.E. degrees or equivalent & technical sales experience.

These positions are open only to executive type sales-liaison engineers capable of dealing with all levels of engineering and management in the airborne and instrumentation fields. Ages 32 to 45 years.

Salary commensurate with assignment and experience within two ranges.

$8,500 to $11,500
$11,500 to $14,000

Liberal Expense arrangements.

Please send complete information.

P-2872—Aviation Week
Classified Adv. Div., P. O. Box 12, New York 36, N. Y.

NEED ENGINEERS

Place an "Engineers Wanted" advertisement in this EMPLOYMENT OPPORTUNITIES section. *It's an inexpensive, time saving method of selecting competent personnel for every engineering job in the Aviation industry.* The selective circulation of AVIATION WEEK offers you an opportunity to choose the best qualified men available throughout the industry.

SPECIAL SERVICES *TO THE* AVIATION INDUSTRY

OVERHAUL & MAINTENANCE

Remmert-Werner

Inc. of St. Louis	Inc. of Florida	Inc. of Toledo
Lambert Field	Pompano Beach Airport	Express Airport
Maintenance	Conversion	Overhaul

Specialists in

Lodestar **DC3** Beech

PARTS & SUPPLIES

NAVCO INC.

Lambert Field
St. Louis, Mo.
PErshing 1-1710

Has all Parts and Supplies for Executive DC-3 LODESTAR BEECH

Airframe Engines Radios
A.R.C. Bendix Collins Lear Sperry Wilcox
P&W Continental Wright Goodrich Goodyear

SALES REPRESENTATIVES

GEORGE E. HARRIS & CO. INC.

SALES–ENGINEERING REPRESENTATIVES

3241 East Douglas Wichita, Kansas

Regional Offices

KANSAS CITY, FT. WORTH, ST. LOUIS,
DALLAS, CEDAR RAPIDS, DENVER & SEATTLE

CLASSIFIED SEARCHLIGHT SECTION ADVERTISING

BUSINESS OPPORTUNITIES — EQUIPMENT - USED or RESALE

RATES

UNDISPLAYED

$2.10 a line, minimum 3 lines. To figure advance payment count 5 average words as a line.

BOX NUMBERS count as one line additional in undisplayed ads.

DISCOUNT OF 10% if full payment is made in advance for four consecutive insertions of undisplayed ads.

DISPLAYED

The advertising rate is $21.00 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page.

Closing date is 11 days before issue date, subject to space limitations.

Send new ads to Classified Advertising Div., Aviation Week, P. O. Box 12, New York 36, N. Y.

WORLD'S FOREMOST
LODESTAR
SERVICE CENTER

Inspection	Radar
Maintenance	Interiors
Instrumentation	Engine Change
Modification	Exteriors
Overhaul	Radio

LEAR
AIRCRAFT ENGINEERING DIVISION
Santa Monica Airport, Santa Monica, California
Builders of the Incomparable Learstars

$50,000

. . . or more offered for substantial interest in established business serving aviation industry. Electronics; instruments; accessory and component manufacturing, etc. Young advertising executive, Ivy League graduate, ex-Naval Aviator Commercial Pilot offers full-time services in sales and management.

BO-2798, Aviation Week
Class. Adv. Div., P.O. Box 12, N.Y. 36, N.Y.

HELICOPTER

Hiller—Model UH-12B. Very low airframe and engine time.

Perfect Condition.

EAST COAST AVIATION CORPORATION
Bedford Airport **Lexington 73, Mass.**

FOR SALE

LOCKHEED LODESTAR

Low time airframe, executive interior, excellent radio.

Contact: **P. H. Carney, P. O. Drawer 12247, Ft. Worth, Texas**

After eight months of negotiation, Remmert-Werner has bought seven DC3 from DHY Turkish State Airlines, and has brought them to their conversion centers in St. Louis, Toledo, McBride, and Pompano Beach, for complete overhaul and modification into private executive aircraft. A & E mechanics spent several months in Ankara disassembling, crating, and moving the planes by cart, truck, and train (35 car loads), to Istanbul, where they were shipped by freighter overseas to Mobile, then by barge up the Mississippi River. They had been unused by DHY since purchase from the USAF, and are the last of the low time DC3-C47s (from one to six thousand hours total).

Each will undergo two to three months of rebuilding, with installation of modern engines and electronic equipment, and will be delivered on a production schedule of one per month, with a new ship guarantee on the airframe, and an 800 hour guarantee on the engines. As they are staggered in various stages of construction, some may be completed with many custom specifications desired by their individual purchasers, including choice of Bendix or Collins executive radio, and choice of engines—Super-92, Pratt & Whitney R1830-75, -92, -94, R2000, Wright R1820-56, -72, etc. Also available to order are such modern improvements as automatic pilot, X or C Band radar, extra Bendix, Collins, Sperry, A.R.C., Wilcox, radio and electronics, Skydrol hydraulic fluid, lightweight landing gear doors, retractable or faired tail wheel, special cowlings, long range outer wing tanks, 26900 manual, additional picture windows, special interiors, etc.

The DC3 is a proven all-weather ship, "the world's most experienced airplane", and is still the most generally practical and efficient large executive aircraft available today, unsurpassed and unreplaced by later design. It has unquestioned dependability, with long range, high chock to chock speed, big capacity, big cabin, small airport ability, unequalled flexibility, top performance and handling characteristics, for economical maintenance and operating costs lower than those of many smaller planes. It makes the average business trip a matter of two or three comfortable hours of roomy, convenient, undisturbed privacy, with plenty of accommodations for extra passengers or baggage. Drop a line to Remmert-Werner today for an interesting history of this ubiquitous campaigner, with many fascinating anecdotes about its remarkable, many sided civilian military, commercial, and private careers.

Presently available are two executive DC3's which are available for immediate delivery with customer's choice of Collins or Bendix radio, and choice of engines. Both have been completely disassembled and overhauled, and carry a new ship guarantee on the airframe, and an 800 hour guarantee on the engines. One, N50F, is a deluxe DC3 which is today's fastest and quietest, with lightweight landing gear doors, retractable tail wheel, flush loops, and many other improvements. Further details may be had from Remmert-Werner, Inc., Lambert Field, St. Louis, Missouri.

RAS INCORPORATED

"Take a Heading for Reading"

for the BEST MAINTENANCE • OVERHAUL • MODIFICATION • INSTALLATION

READING AVIATION SERVICE, INC.

Municipal Airport **Phone 3-5288** **Reading, Pennsylvania**

- COLLINS
- BENDIX
- SPERRY
- LEAR
- ARC

Page AIRWAYS INC.
ROCHESTER AIRPORT
PHONE GENESEE 7301
ROCHESTER 11, N.Y.

RADAR • DME
AUTOMATIC PILOTS
NAVIGATION AND
COMMUNICATION SYSTEMS

WRIGHT—P&W
ENGINES & PARTS

R1820
R1830
R2600
R2800
R3350

CALIFORNIA AIRMOTIVE • CORPORATION

7139 Vineland Avenue,
North Hollywood, California
POplar 5-6202
STanley 7-8374

Grumman Mallard
SERIAL J-29

Now in overhaul—can be finished to your colors and specifications.

Airframe total time:	2300 hours
Airframe time SOH:	Zero hours
Engine time SOH:	50 hours

Sale or lease terms on request

WILLIAM C. WOLD ASSOCIATES
551 Fifth Avenue, New York 17, N. Y.
Cable: BILLWOLD Tel: Murray Hill 7-2050

FOR SALE LOCKHEED L-10

P & W SC1 1340 Engines less than 500 Hrs Since New Airline Interior: Lavatory—Radio—VHF—HF—ADF 3 Seats & Lounge for 3 (12 Passengers) Individual Air Vents & Fans—Extra Engine and Spares Available

CALIFORNIA CENTRAL AIRLINES
HANGAR No. 3 Lockheed Air Terminal
Burbank, California

JET ENGINES
Westinghouse Type—J-30-20

FOR SALE At

TEXAS AVIATION MATERIAL
3930 Cedar Springs Dallas 19, Texas

Immediate Delivery
We stock, overhaul, and install

WRIGHT	PRATT & WHITNEY
R1820	**R1830**
–202, –56, –72	–75, –92, –94

R2000 R1340 R985

and our most popular DC3 engine
R1830 - SUPER - 92

ENGINE WORKS
Lambert Field Inc. St. Louis, Mo.

DOUGLAS C-54-E

3600 GALLON FUEL SYSTEM
73,000 LB. GROSS TAKE OFF WEIGHT
CARGO DOOR & CARGO FLOOR

CASH SALE or WILL FINANCE

ZERO TIME

AIRFRAME - R2000-7M2 ENGINES - PROPELLERS - COMPONENTS - COMPLETE AIRLINE RADIO & INSTRUMENTS

15 DAY DELIVERY

ALSO ZERO TIME R2000-7M2 ENGINE & BUILDUP
DIRECT SALE BY OWNER

WIRE - CABLE - WRITE
FS-2753, Aviation Week
68 Post St., San Francisco 4, Calif.

SPARKPLUGS WANTED

Surplus or used aircraft sparkplugs wanted. Highest prices paid for R.B. 19R, 48S2, 5/2, 5/3, 5/4, 5/5, 23R, 27-R, 23, 21282, 31282; R.P. 43S; LE 44, 45; L.S. 48; A.C. 181, 281; R.S. 19-2R, 14-1R; R.C. 9R; R2-14-R; R-214; R.N. 5/3; 59082, 61382 638*, 648.

RADIO & ELECTRONICS SURPLUS
13933-9 Brush St. Detroit 3, Mich

AIRCRAFT PRODUCTS WANTED FOR MANUFACTURE

Will buy outright—Prints; Tooling; Parts; Etc., also Corporate Setup
A-N proprietary items especially wanted.

COLLINS AIRCRAFT CORPORATION
1711 W. Florence Ave. Inglewood, California

FOR SALE

Beechcraft D18S - $38,500.00

Hydromatic propellers
Collins radio & ARC course director
Five-place cabin (beige & tan)
De-icer boots
Hi-intensity nav. lights
Grimes rotating beacons

Executive Aircraft Service, Inc.
P. O. Box 7307, Dallas 9, Texas
Telephone: FAirdale-2675

Deal Directly with Owner

HANGARS

U.S. Navy type. 120' clear span by 200' depth Doors 120'x28'

All Steel Constructed. Excellent monetary saving and good delivery if you are considering the construction of a hangar of this size.

TRADE-AYER COMPANY
Linden Airport Linden, N. J.
Hunter 6-7690

AIRPLANES WANTED

Need 50 Bonanzas, Navions, 180's, 170's, 170's, Aero Commanders, Twin Navions, Twin Beeches, etc.
Will Buy Dealers' Stocks New or Used

Vest Aircraft Co.'s Skyranch
BOX 5306, DENVER 17, COLORADO

WANTED

CONVAIR 240 or 340

Send Complete Information and Price to—

W-2308, Aviation Week
1125 W. 6th St., Los Angeles 17, Calif.

ADVERTISERS IN THIS ISSUE

AVIATION WEEK, SEPTEMBER 3, 1956

ADMIRAL CORP., GOVERNMENT LABORATORIES DIV. 70
Agency—Cruttenden & Eger Associates
AEROJET-GENERAL CORPORATION 84, 85
Agency—D'Arcy Adv. Company
AEROTEST LABORATORIES INC. 79
Agency—Industrial Marketing Associates
AIRCRAFT EQUIPMENT TESTING COMPANY 59
Agency—Mahool Advertising, Inc.
AIRCRAFT MARINE PRODUCTS, INC. 36
Agency—M. Russell Berger, Inc.
AIRWORK CORPORATION 66
Agency—Gene Wyble Advertising
AMERICAN GYRO DIVISION, DAYSTROM PACIFIC CORP. 88
Agency—P. W. Voorhees Adv.
AMERICAN MACHINE & FOUNDRY 15
Agency—Fletcher D. Richards, Inc.
AMERICAN SCREW COMPANY 52
Agency—Sutherland Abbott
AMPEX CORP., INSTRUMENT DIV. 7
Agency—Roland Associates
ASSEMBLY PRODUCTS INC. 94
Agency—George E. Duff Advertising

BELL AIRCRAFT CORP. 74
Agency—Baldwin, Bowers & Strachan, Inc.
BENDIX COMPUTER DIV., BENDIX AVIATION CORP. 6
Agency—The Shaw Company

CALIDYNE COMPANY 62
Agency—Meisner & Company, Inc.
CANADAIR, LTD. 24
Agency—Walsh Advertising Co., Ltd.
CARMA MFG. CO. 72
Agency—Franklin Associates
CEE-BEE CHEMICAL CO., INC. 117
Agency—The Ralph Yambert Organization
CHANDLER EVANS COMPANY 14
Agency—Hugh H. Graham & Associates
CLEVELAND PNEUMATIC TOOL COMPANY 92, 93
Agency—Meldrum & Fewsmith, Inc.
CRAIG SYSTEMS INC. 97
Agency—Larcom Randall Advertising

DOELLAM, DIV. OF MINNEAPOLIS HONEYWELL 90
Agency—Louis N. Frank Co.
DOW CHEMICAL COMPANY 67, 80, 81
Agency—MacManus, John & Adams, Inc.

EX-CELL-O CORPORATION 5
Agency—Holden-Chapin-Larue, Inc.

FAIRCHILD ENGINE & AIRPLANE CORP. 35
Agency—Gaynor, Colman, Prentis & Varley, Inc.

GENERAL ELECTRIC COMPANY 8, 9, 10, 11
Agency—G. M. Basford Company
GENERAL MILLS, INC. 91
Agency—Knox Reeves Advertising, Inc.
GLADDEN PRODUCTS CORP. 67
Agency—Weir Advertising
GOODYEAR TIRE & RUBBER CO., INC. 3
Agency—Kudner Agency, Inc.

JET PROPULSION LABORATORY CALIFORNIA INSTITUTE OF TECHNOLOGY 76
Agency—Frank Barnett Cole Advertising
JOHNS HOPKINS UNIVERSITY APPLIED PHYSICS LAB. 99
Agency—Belmont Ver Stanbig, Inc.

KEARFOTT COMPANY, INC. 73
Agency—E. M. Freystadt Assoc., Inc.

LAVELLE AIRCRAFT CORP. 86
Agency—The Roland G. E. Ullman Organization
LEACH RELAY CO., DIV. OF LEACH CORP. ..... 3rd Cover
Agency—Hixson & Jorgensen, Inc.
LEWIS ENGINEERING COMPANY, THE 94
LOCKHEED AIRCRAFT CORP. 46
Agency—Foote, Cone & Belding
LOCKHEED AIRCRAFT CORP. 78
Agency—Donahue & Coe, Inc.

MACWHYTE COMPANY 20
Agency—Needham, Louis & Brorby, Inc.
MAGNETIC AMPLIFIERS INC. 68
Agency—George Homer Martin Associates
MALLORY-SHARON TITANIUM CORP. 57
Agency—Griswold-Eshleman Co.
MARQUARDT AIRCRAFT COMPANY 63
Agency—Heintz & Co., Inc.
MARTIN CO., THE GLENN L., DENVER DIV. 86
Agency—Vansant, Dugdale & Co., Inc.
MINNEAPOLIS-HONEYWELL REGULATOR CO. 60, 61
Agency—Foote, Cone & Belding

PHOTOGRAPHIC PRODUCTS INC. 79
PIONEER CENTRAL DIV. OF BENDIX 89
Agency—MacManus, John & Adams, Inc.

REACTION MOTORS, INC. 12
Agency—J. Wheelock Associates
RED BANK DIV., BENDIX AVIATION CORP. 96
Agency—MacManus, John & Adams, Inc.
RED SEAL METALS CO. 72
Agency—Heintz & Co., Inc.
RESEARCH WELDING & ENGINEERING CO. 74
Agency—Dan Elberts Adv. Service
ROBINSON CO., RALPH C. 94
Agency—Chapin-Damm Adv.
ROHR AIRCRAFT CORP. 98
Agency—Barnes Chase Inc.
ROLLS-ROYCE LTD. 42
Agency—The Wesley Associates
RYAN AERONAUTICAL COMPANY 65
Agency—Batten, Barton, Durstine & Osborn, Inc.

SAFE FLIGHT INSTRUMENT CORP. 44
Agency—Richard & Gunther, Inc.
SCOTT AVIATION CORP. 64
Agency—Melvin F. Hall Adv. Agency, Inc.
SERVOMECHANISMS, INC. ..... 4th Cover
Agency—Sanger-Funnell, Inc.
SIKORSKY AIRCRAFT DIV., UNITED AIRCRAFT CORP. 48, 49
Agency—Lennen & Newell, Inc.
SPENCER THERMOSTAT DIV., METALS & CONTROLS CORP. 69
Agency—Sutherland-Abbott Ads.
SPERRY GYROSCOPE CO., DIV. THE SPERRY RAND CORP. 95
Agency—Reach, Yates & Mattoon, Inc.
STILLMAN RUBBER CO. 62
Agency—Lynn-Western, Inc.
STROUKOFF AIRCRAFT CORP. 77
Agency—J. Wheelock Associates
SUNDSTRAND MACHINE & TOOL CO. ..... 2nd Cover
Agency—Howard H. Monk & Assoc.
SWEDLOW PLASTICS CO. 18
Agency—Francis D. Gonda Co.

TEMCO AIRCRAFT CORP. 54, 55
Agency—McCann-Erickson, Inc.
THERM ELECTRIC METERS COMPANY INC. 57
Agency—Taylor M. Ward Inc.
TRANS-SONICS, INC. 87
Agency—Louis K. Frank Adv.
TRENT TUBE CO. DIV. CRUCIBLE STEEL 16
Agency—G. M. Basford Co.

VERTOL AIRCRAFT CORP. 17
Agency—Gaynor Colman Prentis & Varley Inc.
VICKERS, INC., DIV OF SPERRY RAND CORP. 15
Agency—Witte & Burden Adv.

WEBER AIRCRAFT CORP. 4
WHITTAKER GYRO, INC., DIV. TELECOMPUTING CORP. 75
Agency—Mogge-Privett, Inc.
WYMAN GORDON CO. 22
Agency—John W. Odlin Co., Inc.

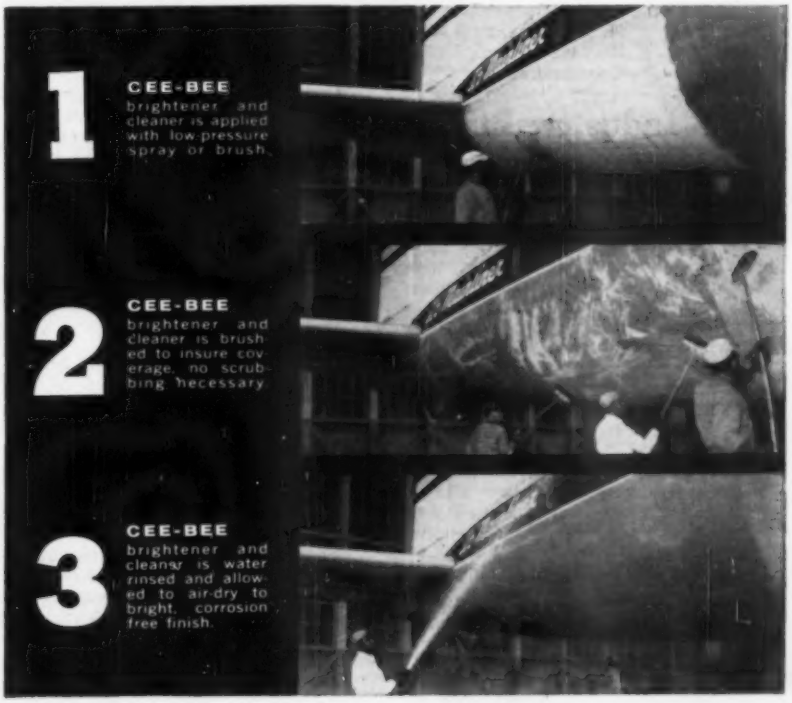
CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 102-114
SPECIAL SERVICES TO THE INDUSTRY 114
BUSINESS OPPORTUNITIES Offered 115
PLANES-EQUIPMENT (Used or Surplus New) For Sale 115-116
WANTED Planes-Equipment 116

Stop Surface Corrosion FAST and ECONOMICALLY with CEE-BEE's Cleaning and Brightening Method

You can eliminate costly aircraft skin replacement caused by surface corrosion with CEE-BEE's 1-2-3 cleaning and brightening materials. The CEE-BEE method is fast and economical – minimizes man hours required on the job and "out-of-service" time of equipment – provides a longer lasting clean surface, free from corrosion causing oil, smoke and exhaust stains and traffic film. And with CEE-BEE, extra polishing retains hi-lustre longer.

Write for free brochure.


1
CEE-BEE brightener and cleaner is applied with low-pressure spray or brush.
2
CEE-BEE brightener and cleaner is brushed to insure coverage, no scrubbing necessary.
3
CEE-BEE brightener and cleaner is water rinsed and allowed to air-dry to bright, corrosion free finish.

CEE BEE

CEE-BEE CHEMICAL CO., INC.
9520 East CeeBee Drive
Downey, California

CB 356

LETTERS

Thanks From ARDC

In behalf of all of us at the Air Research and Development Command I want to express to you and your staff our sincere appreciation and commendation for the outstanding job you have done on the recent ARDC edition of AVIATION WEEK.

The result of your extraordinary effort exceeded my expectations. I am convinced that its benefits will be even greater and more far-reaching than I anticipated. Judging from the comments I have received so far, the impact of this edition will be felt widely and for a long time.

You are to be complimented for your foresight and your understanding of the exigencies of air research and development in compiling such an exhaustive report on all phases of ARDC's activities.

Please convey this expression of appreciation to the many members of AVIATION WEEK's staff who, under your leadership, have worked so hard and for so long to make the ARDC edition a most professional, authoritative and valuable volume.

THOMAS S. POWER
Lieutenant General, USAF
Commander

Research Mission

The ARDC issue of AVIATION WEEK was on my desk this morning when I returned from travel duty.

I want to congratulate you and your staff on the excellent documentation of the ARDC activities. The chapter on the Air Force Office of Scientific Research very clearly presents the mission of this organization, and will be most helpful in publicizing our part in the overall Air Force research and development program.

H. F. GREGORY
Brigadier General, USAF
Commander

From Industry: Bible

Your ARDC issue is a masterpiece. The vital information which you have assembled on all phases of ARDC activities is concise and yet written in sufficient detail to be of inestimable value to our company.

We have worked very closely with ARDC for the past 12 years on navigation aids, counter-measures, and coordinated on guided missile activities, but there is much in your comprehensive documentation which will serve as a Bible for our engineering activities and enable us to do a better job for the Pentagon in our research and development contracts with the various military agencies.

You and your staff deserve real credit for providing the aviation industry with a superb tool to increase our collective effectiveness in the research and development fields.

Please accept the gratitude of Gilfillan for assembling so much helpful information in such an authoritative and usable form.

LEONARD DAVID CALLAHAN
Vice President
Gilfillan Bros. Inc.

Aviation Week welcomes the opinion of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42 St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Navy Sends Praise

Admiral Burke has asked me to write a note of thanks to you for the copy of AVIATION WEEK's Air Research and Development Command edition which you so kindly left at his office.

This is an excellent portrayal of the fine work being done by ARDC. Like all of AVIATION WEEK's special editions it serves as a fine reference book for all of us interested in aviation. As a long time subscriber to AVIATION WEEK, I always keep the special editions available in my desk for ready reference, replacing them each year with the new edition.

WALTER F. CORNNELL
Lieutenant Colonel, U. S. Marine Corps
Aide to the
Chief of Naval Operations

Comprehensive Report

Sincere congratulations on the ARDC edition of AVIATION WEEK, the most comprehensive and factual report ever published about the Air Force's research and development effort!

It has been a privilege to work with you on this far-reaching project, not only because of its great benefit to ARDC's mission but also because it was an enlightening experience to observe the dogged thoroughness and professional competence with which you and your staff tackled this tremendous job.

For a long time to come, AVIATION WEEK's ARDC edition will serve as an invaluable guide and reference to our own personnel, to our contractors and to the many thousands who contribute, directly or indirectly, to the preservation of our aerial supremacy.

Outstanding in every respect, this volume is a credit to you, to the staff of AVIATION WEEK and to the McGraw-Hill Publishing Co.

A. A. ARNHYM
Colonel, USAF
Director of Information Services

The Arnold Story

The article by Bob Cushman in your Air Research and Development issue concerning the Arnold Engineering Development Center is perhaps the best ever written about this Center.

The novel approach, a chronological account of an industry customer's stay at the Center, was a very effective way to tell our story.

I am sure that this article will be of distinct service to many members of the aircraft and engine industry. It reliably informs them of the services and laboratory capabilities available to them here.

The story will help AEDC to carry out better its mission as a development center designed to serve industry and the armed services.

Although many of our engineers are subscribers to your magazine, I would like an opportunity to give a copy of this story to every employe at the Center.

Thus, we would appreciate your permission to reprint several thousand copies for our own use.

JACK SHEA
Special Assistant to Managing Director
Aro, Inc.
Tullahoma, Tenn.

On President's Desk

The ARDC edition of AVIATION WEEK is the best and most valuable issue I have thus far seen.

In fact, I had occasion to use it the first day it arrived. I shall keep it on my desk as a ready reference for all data concerning the Air Research and Development Command.

Therefore, please accept my congratulations for the success of your efforts in bringing to your subscribers such a wealth of valuable information.

You and your staff deserve the appreciation of the entire trade.

ORREN L. JONES, President
Engineering Sales & Service Corp.
1518 K Street, Northwest,
Washington 5, D. C.

WADC Interest

The Air Research and Development Center Edition of AVIATION WEEK, dated 6 August 1956, generated great interest in this laboratory.

The articles on ARDC and its various Centers were concise, extremely informative, and furnished considerable, detailed data not otherwise available.

O. O. SRP
Chief, Electrochemical & Corrosion Section
Protective Processes Branch
Materials Laboratory
Directorate of Research
Wright Air Development Center

Applauds 100% IFR

In reference to Captain Leo Kriloff's letter in the July 30 issue of AVIATION WEEK, (p. 102):

I salute you Captain for having the guts to call a spade a spade. I, too, am a little tired of dodging.

The answer to the present emergency is 100% IFR.

It may slow a few people down, but why should they hurry if they're going to die on the way?

WILLIAM PENN COLEMAN, JR.
Chief Aviation Pilot, USN
Operations Department
NAAS
Beeville, Texas

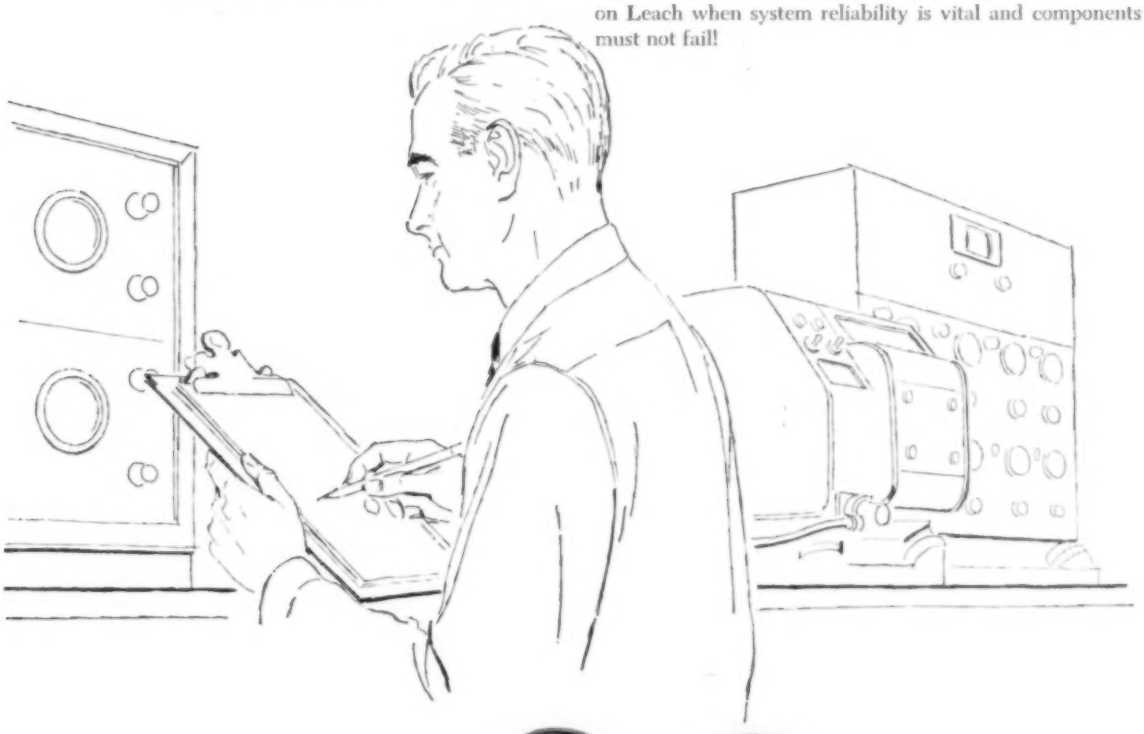
Compare LEACH before you buy

Your own tests will prove why so many critical buyers specify Leach relays

Test any Leach relay against any comparable relay on the market. You'll learn in your own laboratory why the aircraft, missile and avionic industries have learned to look for the Leach label when they're looking for:

- Resistance to greater shock and vibration
- Dependability at higher temperatures
- Space-saving design
- Outstanding reliability

That's why you find designers depending more and more on Leach when system reliability is vital and components must not fail!



Screw terminals

Potted leads

Solder terminals

Plug-in

Leach's family of relays . . . offering the important advantages emphasized above

LEACH CORPORATION / LEACH RELAY DIVISION

Send for the latest Leach Relay Handbook . . . your best starting point when selecting any relay.

5915 AVALON BLVD., LOS ANGELES 3, CALIFORNIA

DISTRICT OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES OF U.S. AND CANADA

E B POWER GS
UNIVERSITY MICROFILM IN
313 N 1ST ST
ANN ARBOR MICH

Crusader..... 1956 A.D.

His weapon—Chance Vought's supersonic interceptor—while infinitely more complex, it must be just as reliable as his forebearer's sword.

Sub-systems such as this Servomechanisms, Inc., Angle of Attack and Mach computer do their part in assuring that American Military Aircraft maintain their leadership in performance and reliability.

SERVOmechaNISMS INC.

WESTERN DIVISION
Hawthorne, California

EASTERN DIVISION
Westbury, L. I., New York

MECHATROL DIVISION
Westbury, L. I., New York

MECHAPONENTS DIVISION
El Segundo, California